ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVIII., No. 2.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 17
The Plant of the Pioneer Electric Power Co., at Ogden, Utah (illustrated)..... 18
A New Compound Air Compressor with Intercooling Receiver (illustrated)..... 21
The Engineering Equipment of the New Southern Terminal Station, Boston, Mass..... 21
Legal Decisions of Interest to Engineers..... 21
Some Water-Hammer Phenomena at the Fresno Hydraulic Power Plant..... 22
Standard Plans for 100-ft. Through Plate-Lattice Girders, No. Pac. Ry. (with two-page plate and other illustrations)..... 23
A Giant See-Saw for the Tennessee Centennial Exposition, Nashville, Tenn. (illustrated)..... 26
Water Ram in the Supply Mains of Hydraulic Power Plants (illustrated)..... 26
A Combined Surface Condenser and Water Cooler (illustrated)..... 26
Tests of an Impulse Water Wheel..... 27
Experiments in Boiler Bracing (illustrated)..... 27
Hydrographs of the Mississippi Flood of 1897 (illustrated)..... 29
The Water Supply of High Buildings (illustrated)... 29
Asbestos and Asbestic..... 29
Equalizing Gear for Operating Machinery of a 246½-ft. Swing Bridge, Chicago (illustrated)..... 30
Book Reviews..... 30
Annual Convention of the American Society of Civil Engineers..... 31
EDITORIAL NOTES..... 24
Amendments to the Constitution of the American Society of Civil Engineers—Elastic Foundations for Gas and Steam Engines.
EDITORIAL:
Difficulties in the Use of Water Power Under High Heads..... 24

LONG DISTANCE TRANSMISSION has received quite a substantial impetus by the signing of a contract between the Southern California Power Co. and the General Electric Co. for an 80-mile electrical transmission equipment. This is really a remarkable step, and shows clearly that modern electrical machinery is reaching a very high degree of refinement. Previous to this the Ogden-Salt Lake City plant in which power is transmitted a distance of 36 miles, held the record. The new California plant will be over three times as long, will transmit four times the power and will have a line pressure three times as great as the present Niagara Falls and Buffalo transmission plant. The power station will be located twelve miles from Redlands and will utilize the river running through the Santa Ana Canyon. The present plan is to draw water from this river at its junction with Bear Creek and convey it by means of suitable canals, tunnels and flumes along the canyon sides to a point where the riveted steel pipe line will begin. This will have a vertical fall of 750 ft. in its length of 2,200 ft. Four impact wheels will drive four General Electric, three-phase generators, each of 750 K-W. output, to which they will be directly connected. 250 K-W. step-up transformers will raise the pressure to 33,000 volts. This unusually high line voltage is considered advisable owing to the very great length of the transmission. It will necessitate especial care in general insulation and line construction but can be safely handled with present apparatus. Prof. E. M. Boggs, of the Arizona University, has been engaged as Chief Engineer for the Power Company.

A NEW DESIGN OF MULTIPHASE GENERATOR has been recently developed by the engineers of the General Electric Co., which is notable for the simplicity of its construction. This dynamo is a three-phase alternator with rotating fields and stationary armature, a design which so greatly facilitates the security of high insulation upon the armature that the dynamo can generate currents with pressures up to 5,000 volts. The machine is thus admirably adapted for long distance power transmission as it dispenses with the necessity for step-up transformers in the power station. The rotating field has a substantial spider supporting a soft steel yoke ring magnetized by removable coils constructed to permit free ventilation. Current at low voltage is supplied to this field by two collector rings mounted upon the shaft. The armature coils are wound on forms and afterwards placed about the poles, and thus a large portion of the coils remain exposed for ventilation. While these alternators have excellent inherent or self-regulating properties, they are sometimes compounded to insure accurate automatic regulation. Large generators of this type will be installed in the great Lachine Rapids plant, in the new Brooklyn Edison station and in London for the Central London Underground Ry.

STORAGE BATTERIES ARE FINDING a new field of usefulness in connection with electrically driven elevators in office buildings. The amount of work done in the operation of an elevator varies through a wide range at different periods of the day, and starting and stopping also cause the load on the engine to be uneven during each trip. The engine and electrical generator are consequently always working under unfavorable conditions, and the steam consumption per horse power is very high. By the use of storage batteries between the dynamo and the motor the engine may be proportioned for the average load of the motor, instead of for the maximum, the battery storing its energy during periods of light loads and giving it out when there is a heavy load. In a letter by Mr. Chas. Blizard, published in the "Electrical Review" for June 9, he claims that by the installation of a battery a current may be obtained for both lighting and elevator service at the same potential from one generator.

A NOVEL PIPE FOR TRANSMITTING HYDRAULIC pressure is in use at the Victoria bridge, at Queensferry at the mouth of the river Dee, 6½ miles from Chester, England. It is a solid drawn lead pipe, covered with close coils of copper wire, and is used for conveying water at 750 lbs. per sq. in. from one side of the river to the other, to operate the machinery of the movable central span of the bridge. The bridge, which is illustrated in "Engineering" of June 11, is itself a rather remarkable structure. The central span is 120 ft. in length between the faces of the piers, and it is bridged by two movable cantilevers, the front end of each of which projects 60 ft. from the face of the pier, the rear end being carried on six cast-iron flanged wheels 4 ft. 4 ins. in diameter, by means of which the movable cantilevers are rolled back into the fixed spans, in order to open the bridge to passing vessels. The cantilevers are moved by hydraulic rams operating a steel wire rope. Since the hydraulic pressure has to be conveyed across the river for the purpose of operating the half span on the opposite side, a pipe has to be laid on the bed of the river. At first a copper pipe 1½ ins. in internal diameter, jointed with screwed unions, was used, but the scouring out of the river bed by the tidal "bore" left the pipe unsupported over two hollow places respectively 50 and 80 ft. in width, causing the pipes to leak. The new pipe, made of lead wrapped with copper wire, being more flexible than the old one, has thus far worked successfully.

A FAST RUN OF 55½ MILES IN 48 MINUTES was made July 2 between Camden and Atlantic City, N. J., on the Atlantic City R. R. The run was made by the so-called "60-minute train" recently put in service and scheduled to leave Philadelphia at 3:40 p. m. and to arrive at Atlantic City at 4:40 p. m. In the regular schedule eight minutes are allowed for ferrying and transferring the passengers from Philadelphia to Camden, so that the train leaves Camden at 3:48 p. m., and to arrive on schedule time at Atlantic City must run 55½ miles in 52 minutes. On the date the first run was made there had been a delay of 2½ minutes on the ferry and with this set-back the train reached Atlantic City 1½ minutes ahead of time, thus running the 55½ miles in 48 minutes. The train consisted of one combination car weighing 57,200 lbs., three passenger cars weighing 59,200 lbs. each, and one Pullman parlor car weighing 85,500 lbs., or a total train weight behind the tender of 323,300 lbs., and was hauled by the standard Atlantic City R. R. Co.'s four-cylinder compound locomotive No. 1027, built by the Baldwin Locomotive Works. This locomotive has two pairs of driving wheels 84¼ ins. in diameter, with 13 ins. and 22 ins. diameter cylinders and 25 ins. stroke. The firebox is 113⅞ ins. long and 96 ins. wide. The boiler has 278 tubes 1¾ ins. diameter, and the total heating surface is 1,835 sq. ft. The total weight of the locomotive and trucks is 226,900 lbs., and the total weight of the engine and train was 547,200 lbs. A letter to us from Mr. Edson Weeks, General Passenger Agent of the Philadelphia & Reading Ry., of which system the Atlantic City R. R. is a part, states that the fast run was made during a heavy thunder storm, with a very heavy wind, and that the engine driver had to slow down a number of times on account of not being able to see clearly ahead.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a freight wreck July 6 on the White Mountain Division of the Boston & Maine R. R., caused by a washout at a point about fourmiles north of Woodsville, N. H. The engineer, fireman and one brakeman are reported killed.

A LOCOMOTIVE BOILER EXPLODED on the Chicago & Northern Pacific R. R., near Morgan Park, Ill., July 1. The engine was drawing a train of four coaches well filled with passengers. While running at a high speed the boiler exploded, throwing the engine from the track and causing the first car to partially telescope on the tender. The fireman was mortally injured, and ten other persons received injuries more or less serious.

A SERIOUS STREET RAILWAY ACCIDENT occurred in Pittsburg, Pa., on July 6, in which four persons were fatally injured and eighteen or twenty were hurt. The accident occurred on the Forbes St. line of the Consolidated Traction Co. at a time when hundreds of people were returning from a fireworks display. A single car, heavily loaded, ran off the track when about half way down Soho Hill. A following train, consisting of an open car and trailer, both packed, ran into the first car. Before the passengers could recover from the shock a third car, also loaded, crashed at full speed into the already wrecked cars and injured people. The accident is an excellent illustration of the danger which always exists in running cars or trains without a proper space interval, unless the speed limit is very low, as in the case of street cars drawn by horses.

A THRESHING MACHINE BOILER EXPLODED at Hartsville, Tenn., July 6, resulting in the death of nine people and the injury of five. Another boiler explosion in Allegheny, Pa., in which three boilers at the salt works of Haller, Beck & Co., blew up, killing two men and badly injuring a third is reported.

A STRIKE OF COAL MINERS in a number of states is now in progress as the result of an order issued by the National Executive Board of the United Mine Workers of America. The demand is for higher wages. The magnitude of the strike is uncertain at the time of going to press, but there are indications that it will be a notable one, extending through all the soft coal regions east of the Mississippi River.

THE APPRENTICESHIP QUESTION, which was a prominent feature of the discussions at the recent convention of the American Foundrymen's Association, in Detroit, has been the subject of a conference between Mr. John A. Penton, Secretary of the Association, and Mr. Martin Fox, President of the Iron Molders' Union of North America, with reference to arranging details of a permanent apprenticeship system in the molding trade. Mr. Fox has expressed his views in favor of the proposed indenture system in a letter to Mr. Penton, in which he concludes as follows:

As the representative head of the I. M. U. of N. A., I would not be justified in pledging its support to the forms of indenture you submit, for, as you are aware, our laws regulating these matters are determined upon by a convention of the entire organization. But I again assure you that I will co-operate in every way possible to enable you to accomplish the very evident desire of your association and will be at your service at any time to this end.

I am a firm believer in the indenture system, and am fully in accord with the determination to insist upon a boy completing his term with the firm with which he starts, providing, of course, there are not good and sufficient reasons to the contrary.

Uniformity in this matter would, I believe, prove much more satisfactory and profitable to foundrymen than the present unsystematic and predatory system.

CIVIL SERVICE EXAMINATIONS of candidates for positions in the Department of Public Works of the City of New York are announced as follows: July 14, engineer inspector of regulating, grading and paving. This position is one particularly desirable to recent graduates in engineering and is in the line of promotion. The salary ranges from $900 to $1,200 per year. July 19, assistant and junior assistant draftsman of the Board of Education. The duties of these positions are those of architectural draftsmen and relate chiefly to new buildings of fireproof construction. The salary of the assistant draftsman will be from $15 to $25 per week; and of the junior assistant, $6 per week. An examination will also soon be held for the position of hydrographer in the Dock Department, at a salary of from $900 to $1,500. The Secretary of the Civil Service Commission is S. William Briscoe, new Criminal Court Building, New York city.

THE NEW CHEMICAL FIRE EXTINGUISHER, consisting of dry powder, which has recently been put onto the market by the Howard Mfg. Co., of New York city, was tested before a number of officials of the New York Fire Department on July 1 to determine its efficiency in putting out elevator shaft fires. A wooden house 7 ft. high and 12 ft. wide, with a shaft 3 ft. square and 36 ft. high at one end, was constructed to represent an ordinary apartment house hallway with a dumb-waiter shaft at one end. Tar and kerosene were smeared onto the walls of the house and shaft and fire set to them and allowed to burn undisturbed until the flames poured out of the top of the shaft. The powder, which is put up in tin cylinders about 1½ ins. in diameter and 18 ins. long, was then flirted onto the fire from the open ends of the tubes. In 17 seconds from the first application of the powder, during which time three 3-lb. tubes were used, the flames had been extinguished except for a few flickering remnants which were all put out by the application of a little more powder. As showing the ability of the new extinguisher to put out flame under the conditions described the test was a decided success. Some of the advantages of this extinguisher were stated in our issue of June 10.

THE RECLAMATION OF SUBMERGED LAND in Jamaica Bay, Long Island, has now been in progress for about four years. In this bay are about 40 or 50 small islands, and the Kings, Queens & Suffolk Co., Frederick W. Dunton, President, has been organized gradually to reclaim this waste land by dredging and filling in. The present plan of improvement includes about 22 islands, embracing about four square miles of territory, and some of this land is now ready for occupation. The land lies within Greater New York, and the project includes the laying out of streets, water distribution and electric railway communication with the main land and its railways.

THE PLANT OF THE PIONEER ELECTRIC POWER CO. AT OGDEN, UTAH.

We give below some information, in addition to that already published in Engineering News,* regarding the hydraulic electrical power plant and irrigation works of the Pioneer Electrical Power Co., near Ogden, Utah. This information is extracted from an extended illustrated description of the plant presented before the annual convention of the American Society of Civil Engineers, just held at Quebec. The author of the paper, Mr. Henry Goldmark, M. Am. Soc. C. E., of Chicago, was a member of the engineering staff in charge of the work. As there have been a number of changes in the original plans, we give below Mr. Goldmark's general outline of the work, slightly condensed, which comprises a fair description of the main features of the plant:

The average annual rainfall in Ogden is 14 ins. In the Ogden Valley it has never been measured, but is probably twice as great. The drainage area is about 360 sq. miles. The flow of the river varies greatly in different years and at different seasons. In May and June, when the snow on the mountains melts, a maximum flow of 4,800 cu. ft. per sec. has been measured, while a minimum of 80 cu. ft. in August and September is also on record. The minimum in average years is fully 125 cu. ft. per sec. In 1896 the flow did not go below 175 cu. ft. per sec. This refers to the flow of the river-bed near the dam site, but there is also considerable underflow in the gravel, as appears from the fact that the gage readings several miles lower are always greater, though the affluents on this stretch are insignificant.

FIG. 1.—VIEW OF 6-FT. WOODEN CONDUIT FOR PIONEER ELECTRIC POWER PLANT, OGDEN, UTAH.
C. K. Bannister, M. Am. Soc. C. E., Chief Engineer.

The slope of the stream in the upper valley is comparatively gradual, while in the six miles of the canyon there is a total fall of nearly 500 ft. This portion of the river has long appeared an attractive field for the development of power, but apart from a small saw-mill near its mouth there have been only abortive attempts made at utilizing the fall of the stream, and none of these earlier plants are now in operation.

The conception and successful completion of the works belonging to the Pioneer Electric Power Co. are largely due to the efforts of C. K. Bannister, M. Am. Soc. C. E., who, as chief engineer and secretary of the company, has devoted several years to the careful study of the engineering and financial problems involved. Preliminary surveys were made in 1894 and 1895, but it was not until the beginning of 1896 that the location of the plant was definitely settled and actual construction begun.

*See Eng. News, Nov. 8, 1894, for description of these works as then proposed, written by our special contributor, Mr. W. P. Hardesty, C. E., of Salt Lake City, and also a note in our issue of May 23, 1895, regarding the progress of the work and changes in the original plans, prepared from information sent by Mr. Hardesty. The electrical equipment of the plant was briefly described in our issue of Oct. 1, 1896. The proposed concrete and steel dam, in place of the masonry dam originally contemplated, was briefly described in our issue of March 18, 1897.

The plans of the Pioneer Electric Power Co. contemplate the utilization of the waters of the entire Ogden River watershed above the mouth of the canyon for the development of power as well as for irrigation. The central features of the plant are: A large storage reservoir and a masonry dam at the upper end of the canyon; a pipe conduit 6 ft. in diameter; a power house containing water-wheels and electric generators. Besides this, there are electric transmission lines and sub-stations for distributing the power to different points, and an extended system of irrigation canals.

The Storage Reservoir.—This will cover an area of about 2,000 acres, and will have a capacity of nearly 15,000,000,000 gallons. It will be formed by building a dam across the canyon a short distance below its upper end. A number of miles of highway will be covered by water, and it will be necessary to build a wagon road of equivalent length on each side of the reservoir. This will involve heavy rock excavation, and will be expensive in construction.

The Dam.—The dam will be built of concrete masonry and founded on the bed-rock. Its length, measured on the crest, will be about 400 ft. It will be about 60 ft. high above the present river bed, and the foundation will extend about 40 ft. lower, making a total height of over 100 ft. The sides and bottom of the canyon, at the site of the dam, consist of solid limestone rock, but the bottom is overlaid to a depth of about 40 ft. with coarse gravel containing a large amount of ground-water. A spillway for carrying off the flood waters is to be built on the north side of the canyon.

A 9-ft. tunnel has been excavated through the solid rock around the south abutment of the dam, which, at ordinary stages of the river, will be the sole outlet for the water in the reservoir. It is to connect at its upper end to a masonry inlet-tower, with six 60-in. ports and sluice gates for admitting water.

About 100 ft. below the tunnel, and connected to it by a riveted steel pipe 8½ ft. in diameter, the main gate-house is placed. This building contains two 72-in. valves, one of which serves for discharging surplus water, while the other connects with the main conduit.

The Main Conduit.—The main conduit is a pipe line with an internal diameter of 6 ft. Its total length is 31,600 ft., of which 27,000 ft. consist of wooden stave pipe, while the last 4,600 ft., at the lower end, is riveted steel pipe. It is laid in a trench 8½ ft. wide, and covered with earth to a depth of 3 ft. on top. The wooden pipe is located on the side of the canyon with maximum horizontal curves of 14° and vertical curves of 8°, and follows the side of the mountain to a point about half a mile beyond the mouth of the canyon. The hydraulic grade line is assumed to fall at the rate of 0.2 per 100, and the wooden pipe line is kept close to, but below, a gradient of this slope, which begins at low-water level in the reservoir. The upper portion of the wooden conduit is mainly in earth excavation, but towards the mouth of the canyon the trench was excavated almost entirely in limestone and granite rock. There are eight tunnels in the rock, the longest of which is 667 ft. There are also eight steel bridges, with a total length of 560 ft., besides a timber trestle. The maximum hydrostatic head on the wooden pipe will be 117 ft., giving a pressure of 50 lbs. per sq. in. (A view of the wooden conduit as laid along the mountain side is shown by the view, Fig. 1.—Ed.)

The Steel Pipe.—Steel pipe is used at the lower end of the conduit for pressures exceeding that mentioned above. It extends from the lower end of the wooden pipe to the power house, following an alinement which is straight in plan, but is adapted to the contour of the ground by 14 vertical angles. Between these points the pipe is straight, the elbows being formed with radii of 30 ft.

The steel pipe is of 6 ft. diameter till it reaches a point 100 ft. above the power house. Here it divides into two branches, 54 ins. in diameter, which lead to two large receivers, one on either side of the power house building.

The total hydrostatic head from the flow-line of the reservoir, when it is full, to the center of the receivers, will be 516 ft.

The Power House.—This is built of pressed brick, with concrete and rubble footings, and cut-stone trimmings. Its outside dimensions are 135 ft. in length by 50 ft. in width. The roof trusses are of steel, and are supported on steel posts imbedded in the brick walls. The covering consists of standing seam steel roofing laid on a 2-in. sheeting of Douglas fir. A traveling crane of 15 tons capacity, operated by hand power, traverses the building, the track girders being carried by the steel posts. This building contains all the hydraulic and electric machinery used. A smaller, separate building serves as a machine and blacksmith shop.

Machinery.—The pipe line is calculated to deliver 250 cu. ft. per second with a full reservoir, which corresponds to a velocity of flow in the 6-ft. pipe of about 9 ft. per sec. Taking the effective head at 440 ft., the gross available horse power will be about 12,500.

The prime movers used are water-wheels of the impulse type, direct connected to electric generators. The complete plant will consist of ten water-wheels and dynamos, but only five are at present installed, although the power-house building, the receivers, and the machine foundations, have been built in such a way that the whole number of machines can be erected at any time.

The water-wheels are of the Knight pattern, 58 ins. in diameter, with a capacity of 1,200 HP. each, at 300 revs. per min.

The dynamos are three-phase alternating-current generators. They give an output of 750 kilo-watts at 300 revs. per min., and 2,300 volts continuously, with a frequency of 60 cycles per sec.

There are two continuous-current exciters, direct connected with 135-HP. water-wheels. Each exciter gives an output of 100 kilo-watts at 550 revs. per minute, and 500 volts continuously.

In the gallery there are step-up transformers with a present capacity of about 3,000 HP. They receive the current from the generators at 2,300 volts, and raise the voltage to 16,100, at which pressure the current passes into the transmission lines. The long-distance transmission lines are, at present, about 38 miles in length, extending to a sub-station in Salt Lake City. They deliver the current, at a voltage of 13,800, to the step-down transformers, which reduce it to 2,300 volts for local distribution. There are, besides this, wires for the local distribution of power in Ogden. The current in these lines has a voltage of 2,300.

The irrigation canals belonging to the company are situated near the shore of Great Salt Lake. The water from the pipe conduit, after leaving the power house, is allowed to run back into the natural bed of the stream, and is again taken out, at a point about five miles below, and diverted, so as to irrigate about 18,000 acres of land, not heretofore provided with water.

All portions of the plant are at present complete and ready for operation with the exception of the large dam and reservoir, the construction of which has not yet begun. A small crib dam with temporary headworks has been built a short distance above the site of the large dam, which gives the necessary head for filling the pipe, but does not provide for any considerable storage of water. A temporary stave pipe, 54 ins. in diameter, extends from the crib dam to the 9-ft. tunnel. In this way the power plant can be operated and a considerable amount of power generated prior to the construction of the large concrete dam.

Some special features of the work may be noted, as follows:

Design and Construction of Steel Pipe.—The thickness of the pipe varies from ⅜ to 11-16 ins., and the receivers are made of ⅞-in. plates. All the joints are butt joints, with longitudinal straps on the inside, and circumferential straps on the outside. The longitudinal straps are 16 ins. wide and ⅜ and ½-in. thick. The pipe was dipped in California asphalt, described by Mr. Goldmark as follows:

The mixture used consisted of C grade of California asphalt, with the interstices filled with the best quality of natural liquid asphalt maltha, not above 14° gravity Beaume test. The mixture was melted and kept at a proper temperature by steam coils in the tank. It was found that a prolonged process of coating gave the best

results, and for this reason nearly an hour was consumed in dipping each section, and gradually withdrawing it from the boiling mixture. The coating was smooth and glossy, and stood the necessary handling without much damage.

Riveting Machines.—One of the most interesting features of the work was the methods employed for trench riveting. The pipe came to the trench in sections 9 ft. 2 ins. long, with the round-about strap riveted on one end. In the shop a steam riveter was used, forming the heads by direct pressure with good results, although it was necessary, especially with 1⅛-in. rivets, to hold on until the heads cooled to a black heat. Split calking machines were used, driven by compressed air. The trench riveting is described by Mr. Goldmark as follows:

The riveting of a steel pipe line of the diameter and length of the Ogden pipe in the short period of time to which the contractor was limited presented many difficulties. For the 1⅛-in. and even 1-in. rivets hand work was not practicable, and it was undesirable even for the ⅞-in. rivets. Power riveters for this class of field work

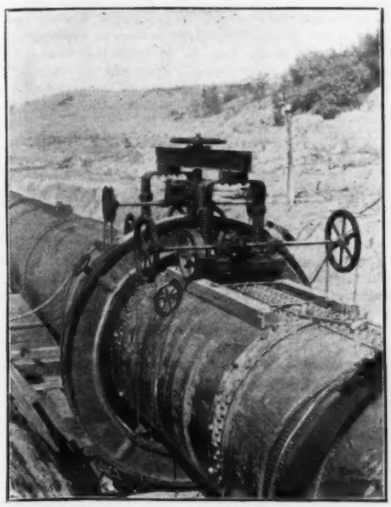


Fig. 2.—View of Machine Used in Riveting 72-In. Steel Pipe in Trench.
Designed by Geo. H. Pegram, M. Am. Soc. C. E.

were almost if not quite untried, and there was little time for experiments. Two forms of power riveters were specially designed for the work, and all the rivets were driven with them, there being practically no hand riveting on any part of the pipe. They were both operated by compressed air, which was drawn from a small pipe laid down on the edge of the trench for the entire length of the steel conduit. This pipe was 3 ins. in diameter where it left the compressor in the boiler shop, decreasing to 2 ins. at the upper end. The pressure used varied from 50 to 75 lbs. per sq. in.

The first type of machine adopted by the contractors and used exclusively in the earlier stages of the work was designed by Geo. H. Pegram, M. Am. Soc. C. E. (See Fig. 2 for views of this machine.—Ed.) The parts of the machine in the inside and on the outside of the pipe are entirely distinct. The former consists of a pressure cylinder and piston, the axis of which coincides with the central line of the pipe, and a framework with a toggle-joint. By means of this the thrust of the piston is turned through 90°, so as to form the heads of two rivets diametrically opposite each other on the inside of the pipe. The cylinder revolves freely on its axis and can be rotated so as to drive in succession all the rivets in a given row. It is supported by means of springs on a low iron truck with wheels, running on a short track which rests on the bottom of the pipe. This machine acts by direct pressure like the steam riveting machines commonly used in boiler and bridge shops.

The portion of this machine outside of the pipe consists essentially of a heavy cast-steel ring which furnishes the necessary reaction against the thrust of the riveting machine inside. For this purpose four cups, adjusted by means of hand-wheels, are attached to the large ring at points 90° apart. The ring hangs from a framework above, which travels on a timber runway supported on the top of the pipe. Gearing is provided for traversing the entire frame, as well as for revolving the ring around the axis of the pipe. When in operation, two rivets are inserted from the outside into holes diametrically opposite; the ring is moved so that two of the cups come exactly opposite the rivets. The hand-wheels are then screwed down and pressure is applied from the cylinder within. All the rivets in a row are driven with one setting, but when a joint is completed the entire machine must be moved ahead, which, for so heavy an apparatus, is rather slow work. About 500 rivets have been driven in a day of ten hours with this machine.

The second type of riveting machine used is much lighter than the one last described. The heads are not formed by steady pressure, but by striking a large number of blows in rapid succession. A frame work encircles the pipe and sustains the internal reaction; it revolves on the pipe on special cast rollers. One rivet only is driven at a time, the head of which is formed on the inside of the pipe. There is an air cylinder with a piston which is moved forward after the rivet is inserted, so as to hold it in place and sustain the blows of the percussion riveter within the pipe. The latter is comparatively light so that it can be handled by only two men working inside of the pipe. It consists of a small air cylinder, similar to that of a percussion rock drill, the piston rod of which has a cup at its outer end. This contrivance is held in place by a heavy rod, fastened into a rivet hole diametrically opposite the rivet to be driven.

The operation is similar to that of the Pegram riveter, and the number of rivets driven per day is about the same. Owing to its greater lightness, the number of men required to handle this machine is considerably less, thus reducing the cost of driving a rivet.

The quality of the work appears to be entirely satisfactory, although for driving the 1⅛-in. rivets, in the 11-16-in. plates, a somewhat heavier machine would be preferable.

Connection Between Wood and Steel Pipes.—Fig. 3 shows the manner of joining the wood and steel conduits, and the steel elbows in the wood conduit at the sharpest bends.

Valves and Other Specials.—A number of air, mud, blow-off and relief valves are provided on the pipe line, besides which there are three 72-in. and two 42-in. gate valves; all of the gate valves are horizontal, with double gates. The three 72-in. valves are described by Mr. Goldmark as follows:

There are two separate stems which are geared together and are operated by a hand-wheel. As the gates of these valves are very heavy, each gate has two bronze disks or wheels placed on the lower side, preceded and followed by a solid bronze scraper or track cleaner. These wheels run on a bronze track fastened to the case of the valve, and the scraper coming close to the tracks keeps them clear of mud and other obstructions, and allows the wheels to hug the track closely and prevent the binding of the gates. These valves were designed to withstand a maximum water pressure of 25 lbs. per sq. in. and weigh about 22,000 lbs. each. As the gate-house was nearly seven miles from the end of the side track, they were shipped in sections and put together on the ground. Although the manufacturers feared that the valve seats might be injured in transit, it is believed that no damage was done, and the gearing was satisfactorily adjusted.

The third 72-in. valve is placed near the elbow No. 2 of the steel pipe line, about 100 ft. below its junction with the wooden pipe. (See the view, Fig. 4.—Ed.) Its purpose is to permit the closing of the wood pipe, so that it can be kept full of water even when the steel pipe is empty. The hydrostatic head at this point is nearly 200 ft. The valve was designed for a pressure of 100 lbs. per sq. in. The construction of a valve of this size and pressure was almost unprecedented. In general arrangement it is similar to the lighter valves previously mentioned, but all parts are, of course, much heavier, and there is only a single valve stem. It has a 12-in. by-pass, and is operated by a hydraulic lift supplied with pressure from the main pipe above the valve.

It is 8 ft. high, and 4 ft. from face to face of flanges, and its extreme length, including the flanges, is 24½ ft. The hydraulic lift cylinder is lined with bronze to prevent corrosion, the spindle within it being steel with a bronze casing 4½ ins. in diameter. The valve stem proper is made of the best bronze. The valve is fitted with the bronze scraper wheels and track already described.

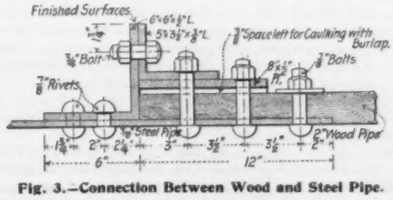


Fig. 3.—Connection Between Wood and Steel Pipe.

The site of this valve was only ¾ mile from the railroad siding, but fully 300 ft. above it, and accessible only by such temporary roadways as had been constructed for building the pipe line. The total weight of this valve is 52,000 lbs. It was, of course, shipped in sections, but it was found impossible to reduce the weight of the heaviest single piece below 20,000 lbs. Transporting such large masses was, of course, slow and difficult, and 24 horses were required to move the heaviest piece. The valve was, however, safely transported and put together without accident. It is believed to be the heaviest valve yet built.

The two 42-in. valves are on the two 54-in. branches to the power-house, the reduction in size being made by the introduction of Venturi meters. These valves were tested to 400 lbs. pressure and have double stems. One of these valves and one of the Venturi meters are shown in Fig. 5.

The air-valves are single 6-in. and gangs of ten 2-in., closed by rubber balls and having an aggregate area equal to the single 6-in. opening.

Outlet Shaft and Stand-Pipe.—These two relief openings are described in the paper as follows:

At station 247, the pipe line is in tunnel and but little below the lower hydraulic grade line, and about 50 ft. below the surface of the ground. This point was selected for the location of an outlet shaft. It is 6 ft. in diameter, and was sunk from the top through the solid rock to connect with the tunnel. With a full reservoir the top of the shaft comes close to the upper hydraulic grade, if the virtual slope is assumed equal to 0.002. The pressure in the pipe below the shaft can never exceed that due to the head of water corresponding to the top of the shaft. This reduces the static head, on the lower part of the pipe line, about 50 ft. In case the lower valves near the power house are closed, this shaft will, of course, overflow until the inlet valves at the dam are closed. A further important function of the shaft is to act as a relief outlet in case of accident to the lower part of the pipe line.

This shaft is not lined, but connects directly with the

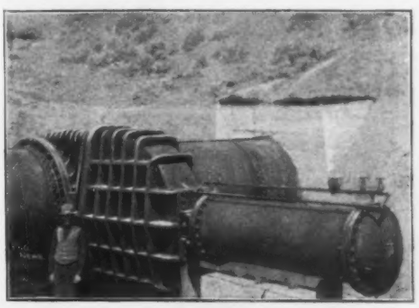


Fig. 4.—View of 72-In. Hydraulic Gate Valve.
Made by Rensselaer Valve Co., Troy, N. Y.

tunnel below. The wooden pipe in this tunnel is left out for a distance of about 100 ft., the pipes being connected to the tunnel by steel angle rings and flanges similar to those used for joining the steel and wooden pipes, and are bedded in concrete.

In addition to this shaft a stand-pipe was built which connects with the 6-ft. steel conduit just below its junction with the wooden pipe, and a short distance above the heavy 72-in. valve. This stand-pipe is a wooden stave pipe, 49 ins. in internal diameter, built of 24 staves and banded in the same way as the 6-ft. pipe. It is laid on a tangent and follows the contour of the ground up to the hydrostatic grade line. It is 550 ft. long, and is intended mainly to act as a safety valve in case the large valves below should be too suddenly closed, or in case of a collapse of the pipe.

These two relief openings will always permit the water to rise freely to the levels corresponding to the pressure at the points where they leave the main conduit. As the pipe is of practically constant diameter and of the same construction from the dam to the lower stand pipe, there will be an excellent chance for determining the true coefficient of friction in the wooden pipe for different velocities of flow.

Hydraulic Machinery.—Our abstract of this paper will be completed with a description of the hydraulic machinery (see Engineering News, Oct. 1, 1896, for details of electrical equipment), and with a statement regarding the engineers and contractors connected with the work. The information regarding the hydraulic equipment is credited by Mr. Goldmark to Mr. L. S. Boggs, Electrical Engineer of the Pioneer Electric Power Co., in charge of its erection, and is as follows:

Receivers.—As noted in the general description of the works, the water is delivered from the pipe conduit into two receivers, which are buried in the ground, one at either side of the power house. (See the view, Fig. 5. The receivers and off-take pipes to the power house are shown just beyond the gate valve and Venturi meter.—Ed.) They are 6 ft. in diameter, and, in their general appearance and the material used, closely resemble the regular steel pipe conduit. It may be noted, however, that the thickness of the metal is increased to ⅝-in. in order to allow for water hammer. Besides this, the edges of all plates and straps were planed, and the rivet-holes reamed out fully ⅛-in. after punching.

The receivers were provided with five safety valves each, which discharge when the pressure exceeds 200 lbs. per sq. in., and an outlet gate at the bottom. From each of these receivers five 30-in. and one 10-in. intake pipes extend to the walls of the power house to connect with the water-wheel nozzle pipes. Between these intakes and the

nozzle pipes are placed the following valves, in order named: One 18-in. geared gate valve, one 18-in. hydraulic gate valve, and one 18-in. butterfly valve.

The 18-in. geared gate valve is only to be used in case of repairs to the particular machine that it governs, and is left open on all other occasions. The 18-in. hydraulic gate valve is piped up to a small D valve, which is placed back of the switchboard and under the floor, and by means of a lever on the switchboard, connected to this D valve, the gate can be opened or closed at the operator's will. This valve is the one which is to be used for starting or stopping a wheel. The 18-in. butterfly valve is operated by means of a worm gear from the governor, and is used in checking the speed of the wheel by reducing the head or pressure near the nozzle, and thus avoiding a sudden fall of head in the main pipe line, which would be detrimental to the proper working of the plant.

The nozzle for the water-wheels has six rectangular openings or ports 1 11-16 × 3½ ins. in area. This nozzle is bolted to a tapering cast-iron pipe, securely fastened to the base of the machine, and the ports in the nozzle are made continuous, with a separation between each of them ½-in. thick. Sliding back of the ports in this nozzle is a tongue, connected to the piston rods of two hydraulic cylinders which are placed one on each side of the head of the nozzle. These hydraulic cylinders are piped to another D valve, under the floor, back of the switchboard,

Fig. 5.—View of Power House, Off-take Pipes, Receiver, 42-in. Gate Valve, Venturi Meter and 54-in. Steel Supply Pipe.

which is also controlled by a lever on the switchboard. The operator is thus enabled to close one or more of the nozzle ports as he may desire. On the opposite side of the water-wheel from these hydraulic cylinders is a hand-wheel, which is geared to a rack that moves a similar tongue for opening or closing the nozzle ports on its extreme end. The levers that operate the hydraulic gate and nozzle are placed near the top of the switchboard. The set of levers for each water-wheel is placed in the panel governing the generator which is driven by the wheel in question, so that the operations required in starting or stopping these machines are reduced to a minimum.

There is also between these levers an indicator with two hands, one showing the movement of the hydraulic gate and the other that of the nozzle.

Water-Wheels.—The water-wheels (Knight) are 58 ins. in diameter, and have 45 bronze buckets cast in one solid piece; 14 of these will, when the nozzle ports are all open, receive the water at the same instant. The centers of the wheels are made of cast steel, the buckets being pressed on these steel centers, and secured with turned bolts, fitted in reamed holes, passing through both pieces of metal. These wheels were bored to fit, and are keyed to the generator shaft, each wheel being faced and perfectly balanced.

Each water-wheel is provided with two fly-wheels, about 70 ins. in diameter, each of which weighs about two tons, and is placed inside of a housing on each side of the wheel. These fly-wheels are banded with ¾ × 5-in. Ulster iron, shrunk on hot. They are split in three parts and are filled with metal, banded, bored to fit, and keyed to the generator shaft. They are turned on the face and nicely balanced.

The armature, armature shaft, two fly-wheels and one water-wheel, which comprise the moving parts, weigh as much as 15 tons, which greatly helps in maintaining a uniform speed, notwithstanding changes of head in the main pipe, or changes in the generator load.

The water-wheel, fly-wheel, nozzle and the two hydraulic cylinders are encased in a steel housing, bolted to the machine bed-frame. On the top of this housing is placed the speed-regulating apparatus or governor, which is driven from the water-wheel end of the armature shaft, and is geared to the shaft of the worm gear which operates the butterfly valve already referred to. There is also a hand-lever on the shaft of this butterfly valve that is used in regulating the opening until the governor picks up, as in the starting of a machine.

Between the two lines of machines and down through the center of the building underneath the concrete floor is the spillway into which the wheels discharge the water, and through which the water is carried back to the river from which it was taken.

On each side of the plant, near the generator switchboard and facing each other, are the registers for the two Venturi water meters.

Engineers and Contractors.—The work was carried out under the direction of C. K. Bannister, M. Am. Soc. C. E., as chief engineer, while Messrs. Willard Young and H. M. McCartney successively held the position of assistant chief engineer. Mr. R. F. Hayward was consulting engineer for the hydraulic and electric equipment, while George H. Pegram, M. Am. Soc. C. E., acted in an advisory capacity as consulting engineer. The location and early construction were in charge of Mr. F. N. Snyder, who was succeeded by Mr. S. E. Reaugh. To the author were entrusted the designing of the pipe conduit and its details, and the studies for the dam, as well as the mathematical and technical work connected with the plant, excepting the electrical and hydraulic machinery and transmissions. Mr. G. E. Rhodes was in charge of the work on the pipe conduit for the contractors, Messrs. Rhodes Brothers.

We are indebted to the General Electric Co., 44 Broad St., New York city, contractors for the electrical equipment, for the photographs from which the accompanying half-tones were made.

Discussion.

R. F. Hayward (consulting electric engineer to the Pioneer Electric Power Co.).—In the design of the electrical equipment the problem was (1) to supply energy for light, power, railways and electrolytic purposes in Ogden and the immediate vicinity of the power house and also in Salt Lake City, 37 miles from the power house; (2) to supply power for smelting and mining purposes at points 10 to 30 miles beyond Salt Lake City. Though coal in the area covered costs only $2.25 per net ton, the steam plants generally operate under adverse conditions which make the cost per annum from $70 to $120 per HP. on 24-hour service.

The three-phase alternating current system was selected on account of its flexibility and economy of transmission. The fact that the smaller three-phase system of the Big Cottonwood Power Co.'s plant at Salt Lake City might eventually be used in conjunction with the Pioneer Electric Power Co.'s plant was also considered. A frequency of 60 cycles per second was chosen, as a very large part of the energy will be used for lighting purposes, and while a lower frequency is at present the most suitable for transforming to direct current it will be but a short time before rotary transformers can be built satisfactorily for 60 cycles. As the power house is about two miles from the center of Ogden, where about 1,000 HP. will be used, it was decided to wind the generators for 2,000 volts, in order to avoid the use of step-up transformers for the Ogden service. The voltage of the transmission line was placed at 15,000 volts, this being as high as it was deemed advisable to go at present, but the transformers have all been tested to 40,000 volts and can be connected up to give 27,000 volts on the lines. If this pressure is successful it will be used regularly, and this will make it commercially possible to transmit power to the mines at Mercur, 40 miles beyond Salt Lake City. The system is arranged throughout in duplicate.

There are two circuits for the local distribution and two for the transmission lines, and the switchboards are so arranged that any generator and any set of transformers can be thrown at will on either one or other of these circuits. Thus one circuit can be used for lighting and the other for street railways and power, in which the regulation is not so important. Every precaution has been taken against interruption in the transmission line, and this will probably be duplicated before long. The lines are thoroughly protected by lightning arresters.

By means of the Venturi water meters and the electrical measuring instruments a continuous record can be kept of the water used, the energy sent out from the power house, and the energy received at the sub-station. The system of measurements is as complete as is possible for commercial purposes. The water-wheels have each two heavy fly-wheels and are fitted with electrical relay governors. The generators will regulate within 5% at constant speed, and the drop on the lines and distributing mains has been kept as low as possible. The specifications for machinery called for a commercial efficiency of 95% on the generators, and this was reached (within a few tenths of 1%) at the factory tests. The transformers have an efficiency of over 98%. The transmission lines will have an efficiency of about 90% when delivering 3,000 HP. at Salt Lake City, with an initial pressure of 16,000 volts. With 27,000 volts the capacity will be about 6,000 HP. for the same efficiency.

D. C. Henny.—With a maximum flow of 250 second-feet through the pipe line, the effective head on the wheels will be about 440 ft. with the reservoir full, and 381 ft. with the reservoir drawn down. This corresponds to 12,500 HP. and 10,800 HP., respectively, or a fluctuation of 1,700 HP. The machinery had to be capable of developing the maximum, and the entire pipe line had to be built for an extra pressure of 59 ft., while more economical structures could have been used for the gates, air valves, etc. Even assuming that the extra power can be depended upon at all times, would it not have been economy to adopt a higher stage of low water in the reservoir, and locate the pipe line correspondingly higher, thereby decreasing the maximum pressures and the cost, at the expense of a small amount of water left unavailable in the bottom of the reservoir?

The author states that he believes the wooden stave pipe to be of greater diameter than any previous conduit of this kind, and refers to the use of Douglas fir for the conduit as a new departure. A 6-ft. stave pipe conduit was built by J. T. Fanning, M. Am. Soc. C. E., at Manchester, N. H. ("Transactions," Am. Soc. C. E., March, 1877), and two 6-ft. pipes have been built by Mr. C. P. Allen, of Denver, Colo.; one on the Maxwell grant, in New Mexico, the other at Gothenburg, Neb.; the writer built a 6-ft. pipe near Poso, Cal., in 1893. Almost all the stave pipes built in Washington, Oregon and British Columbia are of Douglas fir.

For 6-ft. stave pipe, a net thickness of 2 ins. is rather light to ensure rigidity, especially considering that in case of accident or sudden change of flow the air valves cannot operate until after the formation of a partial vacuum. A 1-ft. minimum break of joint for the staves is very short, as 3 or 4 ft. can ordinarily be obtained without extra cost, thereby increasing the longitudinal strength of the pipe. If this short break of joints was necessary to produce curves of the required sharpness the writer would have preferred to use narrower staves. Dependence on the swelling of the staves to tighten the seam joints implies leakage at first filling, but this can and should be avoided by the proper cinching of the bands.

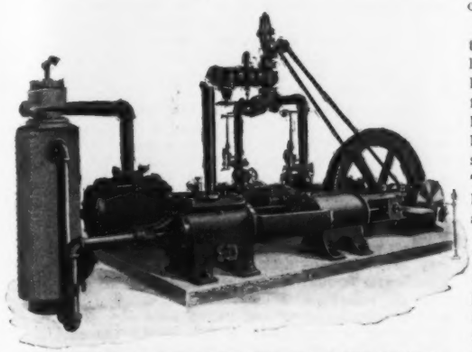
In limiting the calculated unit strain to 14,660 lbs. on steel of 55,000 to 65,000 lbs. tensile strength, the possible factor of safety in the body of the hoop is somewhat less than four. This is further reduced, as no account is taken of the strain caused by the pressure of stave upon stave if the pipe is tight, whether produced by swelling or by cinching, and this is in addition to the water pressure. There seems to be no reason for regulating it, even though it is not proportionately large in this case (on account of the comparative thinness of the staves) and is hard to determine. The factor of safety of the entire hoop is believed to be more seriously reduced by the character of the connecting shoes. This connection should be as strong as the body of the bolt, or metal in the bolt is wasted and the assumed factor of safety seriously reduced.

E. E. Russell Tratman.—Many members may probably remember a newspaper story circulated about a year ago to the effect that in connecting two of the sections of the steel pipe line of the Big Cottonwood Power Co.'s plant, near Salt Lake City, it became necessary to make certain rivet holes, and that these were made by shots from the engineer's rifle. Having seen this story repeated in an English paper (which assigned the rifle to "a workman" instead of to the engineer), and re-repeated here, the writer made enquiry of Mr. R. M. Jones, the Chief Engineer, who replied as follows: "We had a standpipe of ½-in. steel, 7 ft. diameter, which required three holes for connecting the pipe lines from different directions; each of these was 54 ins. diameter, and the plate had to be cut out; therefore we shot it out instead of chipping it out. The apparatus used was merely one of the modern Winchester guns, using smokeless powder or dynamite, with long leaden bullets, copper-coated."

A SAFETY TOP FOR BLAST FURNACES, devised by Mr. F. H. Foote, for the furnaces of the Illinois Steel Co., is illustrated in the "Iron Trade Review" for June 24. Beneath the metal charging floor and surrounding the charging hopper the casing of the top of the furnace is formed of a heavy iron framework resting on an iron ring, placed at the top of the firebrick lining, which framework contains a number of heavy cast-iron doors, placed at an angle of about 30° from the vertical, and hinged at their upper edges to the framework. When an explosion of gas takes place in the top of the furnace these doors swing open and relieve the pressure, while the workmen above are protected from the flames by the metal charging floor.

A NEW PATTERN OF AIR COMPRESSOR WITH RECEIVER INTERCOOLER.

We illustrate in the accompanying cut a new pattern of compound air compressor, with a receiver intercooler, which is being built by the Ingersoll-Sergeant Drill Co., of New York city. Three of these compressors have been purchased by the Atchison, Topeka & Santa Fe R. R. Co., and will be set up in their shops at San Bernardino, Cal., Galveston, Tex., and Albuquerque, N. M., and used to supply compressed air for different car and locomotive shop tools and appliances. The compressor, as will be seen from the illustration, is of the duplex cross-compound type, and has the intercooler located at the rear of the air cylinders and connected with them by pipes, instead of being placed between the cylinders, as is most commonly done. This intercooler is simply a water-jacketed steel tank connected with the low and high pressure cylinders as shown. By this means the air from the low pressure cylinder is stored for some time in the cooler before it is taken into the high pressure cylinder and transferred to the receiver proper.



Duplex Cross Compound Air Compressor with Receiver Intercooler.
Ingersoll-Sergeant Drill Co., New York.

The steam valve gear of this compressor is of the slide valve type, with Meyer adjustable cut-off. The piston inlet air cylinder is 18¼ ins. in diameter and 14 ins. stroke, and the high pressure air cylinder is 11¼ ins. in diameter and 14 ins. stroke. The piston inlet construction admits of an intake box through which air may be drawn from the outside of the building where it is cold and in better condition for compressing than it would be if taken from the engine-room. The air cylinders are provided with water jackets which afford a large area of cooling surface. A special governor controls the speed of the compressor, and the air cylinders are provided with an automatic regulator and unloading device, which controls the action of the compressor when the air is used intermittently and stops when no air is required. This regulator will start the compressor again when necessary, thus using steam only in proportion to the work being done and relieving the engineer for other duties. This compressor has a capacity of about 600 cu. ft. of free air per minute compressed to 100 lbs. gage pressure at a speed of 148 revolutions.

ENGINEERING EQUIPMENT OF THE BOSTON SOUTHERN TERMINAL STATION.

A contract was let recently by the Boston Terminal Co. to Westinghouse, Church, Kerr & Co. for an unusually comprehensive and complete engineering equipment of its new station. The station itself was described in our issue of Nov. 14. The contract is notable, not only on account of the extent and cost of the work, the latter being considerably over $500,000, but on account of the variety of the equipment which is entrusted to one firm of contractors instead of dividing it among several, as is the usual custom.

The various sections, each of which is complete in itself and yet more or less connected with the others, are as follows:

1. Signalling and switching. 2. Power house equipment. 3. Electric arc and incandescent lighting. 4. Elevators and lifts for passenger, freight and baggage service. 5. Heating and ventilation. 6. Ice making for car and restaurant use, etc. 7. Refrigeration for restaurant, kitchen and storage boxes. 8. Cooling water supply for head house. 9. Car heating in train shed, storage and express yards. 10. Air brake testing. 11. Fire protection. 12. Disposal of drainage from water-proofed structure. 13. Frost protection for roof conductors. 14. Steam and hot water supply for head house.

While differing widely from each other, the various sections, to a large degree, are inter-related in connection with the operation of the terminal as a whole, and many economies, both of cost and operation, have been made possible by the opportunity to design and construct them all as component parts of one complete engineering outfit.

The switching and signalling covers the installation of the complete apparatus of the Westinghouse electro-pneumatic interlocking system for handling all of the trains of four railways to and from the train shed of the terminal, and the handling of the suburban trains through the suburban loop. Several hundred levers will be installed for handling the switches and signals. The air compressors for the switch work will be located in the power house, as also the electric apparatus for the signal and interlocking control.

The power house equipment will consist of ten boilers, fitted with economizers and mechanical draft and about 1,500 HP. of Westinghouse compound engines direct connected to Westinghouse multipolar generators. The plant will be operated condensing, using salt condensing water, except when the steam is required for heating. A large switchboard, carrying a dozen or more circuits for the various uses of electric current, will be provided. A traveling crane will span the engine room.

The electric arc and incandescent lighting employs a somewhat larger number of distributing centers than is customary in isolated plants, in order to meet the demands of the lighting and motor circuits, and also to aid in economizing power. In addition to the usual wiring conduits, extra ones are added for miscellaneous wiring for other purposes and also for telephone service.

The elevators and lifts for passenger, freight and baggage service comprise nineteen electric elevators.

The heating and ventilating of the head house and side wings, which, together, form a building extending around three sides of the train shed and having a total length of about 1,800 feet, is performed by a combination of the direct and indirect method, with hot blast and tempered air furnished by fans driven by electric motors, while the ventilation is assisted by exhaust fans also driven by electric motors, with separate exhaust systems for the sanitaries.

The ice making plant for car and restaurant use is a 20-ton plant to make "diamond" ice on the plate system.

The refrigerating plant for the restaurant, kitchen and storage boxes is of the usual form, and is to be erected in connection with the ice plant.

The cooling water supply for the head house is an adjunct of the ice and refrigerating plant, and is arranged to filter and cool water under city pressure, distributing the supply to some 25 taps located throughout the head house.

The car heating in the train shed, storage and express yards covers an extensive system of steam piping, extending over about 40 acres of tracks and adapted for heating cars in all locations where they may be detached from the engines. While in the main the distribution of steam over large areas is a comparatively simple problem, the miscellaneous car heating over such areas involves many special features, all of which have been carefully considered in connection with this work.

The air-brake testing arrangements comprise the carrying of compressed air to the 28 sub-tracks in the train shed, and to nearly as many more in other sections of the yard, with the proper appliances for testing the air-brakes on cars preparatory to sending out trains.

The fire protection of the head house and wings includes suitable service mains and distributing lines, served by the high pressure fire service mains of the City of Boston, and provided with a large number of outlets fitted with hose and reels. Provisions are made enabling special protective apparatus to be added as required.

The disposal of drainage from the water-proofed structure involves somewhat unusual considerations, due to the fact that a large portion of the subway structure is 10 or 15 ft. below tide water, necessitating extensive water-proofing. The grade of the suburban tracks necessarily throws their water shed towards the head house and provision is made for taking the storm water of this incline and possible seepage through water-proofing to a sump which is provided with electrical pumping apparatus adapted to automatically keep the water below a dangerous level, or, in event of an emergency, to enable pumps to be put in service to handle large quantities of water and avert a rise materially beyond the danger level.

Frost protection for roof conductors is required on account of there being some 14 acres of roof, the storm water from which is carried to many large leaders, the freezing of which in winter would cause great inconvenience. Special provisions have been made for keeping these conductors open.

The steam and hot water supply for the head house covers the special all-year-round supply of steam and hot water for miscellaneous purposes—washing, cleaning, etc., and is wholly separate from the heating system, which is in service only during cold weather.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Risks of Contractor.

Under a contract with a city to construct a newly designed apparatus for filtering water, to stand certain tests, the risk that the apparatus will stand the tests and demands made upon it is upon the contractor.—Schoenberger v. Elgin (Sup. Ct., Ill.), 45 Northeastern Reporter, 634.

Right of Inspection of Sewer.

Under a contract for the construction of a sewer, providing that the certificate of the inspector of materials and work to be appointed by the city should be a condition precedent to the contractor's right of payment, an action by the contractor will not lie to recover damages based upon the increased cost of the work alleged to be due to delay caused by conduct of the inspector in rejecting material which was in fact in accordance with the plans and specifications. The tacit consent of the contractors to the action of the inspector, as manifested by the procurement of other material and continuance of the work, will prevent them from complaining of his action.—Montgomery v. New York City (Ct. App., N. Y.), 45 Northeastern Reporter, 550.

Municipal Corporations in Indiana.

Municipal corporations in Indiana possess only such powers as are granted by the legislature in express words, and those necessarily implied by the powers expressly granted. An ordinance will not be upheld by virtue of the incidental powers of a municipality, or under a general grant of authority, unless it be reasonable and not oppressive.—Pittsburg, etc., Ry. Co. v. Crown Point (Sup. Ct., Ind.), 45 Northwestern Reporter, 587.

Limitation of Indebtedness in Indiana.

Where a city contracted for a fire-alarm system at a time when it was indebted beyond the constitutional limit, and it had no money in its treasury to pay for such system, either at the time the contract was made or when the system was completed and accepted, such contract was within the prohibition of the constitution of the state of Indiana, though the city had on hand sufficient money to pay for same at the time fixed for payment.—La Porte v. Gamewell Fire-Alarm Tel. Co. (Sup. Ct., Ind.), 45 Northeastern Rep., 588.

When Interest Cannot be Collected from City.

A contract for street improvement provided that the contractor should make no claim against the city in any event except for the collection of the special assessments, and that the city would not be liable in any event because of their invalidity, or failure to collect the same. After the work was done, the city council, by resolution, directed all proceedings for the collection of the assessments stayed, and the assessment was not collected for at least one year after it should have been. The Supreme Court of Illinois held that the contractor was not entitled to collect from the city interest on the assessments for the time their collection was delayed; as the conduct of the authorities in causing the delay was not so far tortious or wrongful as to render the city liable for interest during the delay, as a municipal corporation is not liable for interest on claims, in the absence of a contract providing for same, except where money is wrongfully obtained and illegally withheld by it.—Vider v. Chicago (Sup. Ct., Ill.), 45 Northeastern Rep., 729.

Electric Light and Trolley Wires.

An electric street railway and light company constructed its railway in such a manner that the support and span wires, which passed over the trolley wires, might become dangerous by contact with the trolley wire, unless properly insulated. A lineman of the company received an electric shock from taking hold of a support wire, due to the fact that a span wire, which was not insulated, had come in contact with the trolley wire. The Supreme Court of Errors of Connecticut, held that the company was guilty of negligence rendering it lia-

ble for the injuries received; for an electric railway company, operating its cars by the overhead trolley system, is required to use every reasonable precaution, known to those possessed of the kuowledge requisite for the safe treatment of electricity as a motive power, to provide against the danger of injuries to its employees.—McAdam v. Cent. Ry. & Elec. Co., 35 Atlantic Reporter, 340.

What is Not Fraud on Part of City Contractor.

Fraud, to render void acceptance by a board of public works of work for a municipal improvement, must be on the part of the contractor in connection with the act of the board in the approval of the work. That the contractor did or did not do the work in compliance with the contract, or that the abutting owner notified the board that the work was not done according to the contract, and they refused to take notice of the information, does not taint the work with fraud.—Darnell v. Keller (App. Ct., Ind.), 45 N. E. Rep., 676.

Trespasser on Street Car.

Where it appears that a boy was riding on the rear step of a street car, but that the conductor did not put him off or pay any attention to him, and he jumped off and was killed by falling on the cobble-stones of the street, it is proper to direct judgment for the company.—Brightman v. Union St. Ry. Co. (Sup. Jud. Ct., Mass.), 45 N. E. Rep., 1091.

Raising Street Grade Not a Damage.

Raising the grade of street, says the Court of Appeals of New York, by building approaches for a street bridge to abolish grade crossings of a railway is not a taking of property of abutting owners, so as to entitle them to damages.—Talbot v. N. Y. & H. R. Co., 45 N. E. Rep., 382.

Burden of Proof in Damage Suit.

The concurrent facts of the happenings of an accident to a passenger on a street railway car and the exercise by the passenger of ordinary care do not raise a presumption of negligence on that part of the company, so as to shift the burden of proof on it, where the evidence of the claimant shows that the accident was due to a wagon driven so close to an open car as to strike his foot.—City Ry. Co. v. Rood (Sup. Ct., Ill.), 45 N. E. Rep., 238.

Reasonableness of Rule as to Tender of Fare.

In an action for an assault, it appeared that complainant tendered a five-dollar bill to the conductor in payment of a five-cent fare, stating that it was the only money he had with him, and the conductor refused to make change and ejected him from the car. It was stipulated that there was a rule (not brought to complainant's notice) requiring conductors to change to the amount of two dollars only; but there was no rule forbidding changing larger bills. There was no evidence of custom as to making change, except that complainant testified that he had had such bills changed on former occasions. The Court of Appeals of New York held that the tender, as a matter of law, was unreasonable, and the court should have directed verdict for the company.—Barker v. Central Park, etc., R. R. Co., 45 N. E. Rep., 550.

When House Owner Cannot Collect for Defective Sewers.

A party cannot recover against a city for injury to his houses caused by the set-back to the sewage through the alleged negligence of the city, where he connected his houses with the sewer in such a way as to be in violation of city ordinances; and the fact that the city pumped the water out of his basements will not act as a waiver of the infraction of the ordinances.—Breuck v. Holyoke (Sup. Jud. Ct., Mass.), 45 Northeastern Rep., 732.

Regulation of Price of Gas Must Be Reasonable.

Under an act of a state legislature authorizing a taxing district to regulate the price of gas furnished by gas companies with such taxing districts, provided the price shall not be fixed below a certain minimuun, such power to regulate cannot be exercised arbitrarily, without investigation of the facts bearing upon the reasonableness of the rate to be fixed, or in such a manner as to bring about a destruction or confiscation of the property of the gas companies; but due regard must be given to the right of such companies to receive such an income from their business as to pay operating expenses, legitimate fixed charges, and a reasonable profit.—New Memphis G. & L. Co. v. Memphis (U. S. Circuit Ct. Dist. Tenn.) 72 Federal Reporter, 952.

Liability of Water Company for Overflow.

The Supreme Court of Ohio says: One who collects, on his own premises, a substance liable to escape, and, if it should escape, likely to cause mischief and damage, must, at least, use reasonable care to restrain it. If for want of such care it escapes and injures persons or property rightfully on adjoining premises, he is answerable for the damages sustained on account of such negligence.—Defiance Water Co. v. Olinger, 44 Northeastern Reporter, 238.

Negligence as to Trolley Supports.

A party, while walking in a public highway, was injured by the breaking of a wire cable used by a street railway company to control its cars on a steep incline. There was evidence that the cable, which had become weakened by use, had broken once before, and been hastily repaired on the morning of the accident, and used without testing. The Supreme Court of Pennsylvania held that testimony to show that the attention of one of the directors of the company was called to the weakened condition of the cable was admissible, and the jury should determine as to negligence.—Musser v. Lancaster City St. Ry. Co., 35 Atlantic Reporter, 206.

Expert Testimony as to Value of Services of Civil Engineer.

The Supreme Court of New York recently held that, in an action for services as a civil engineer, where such party had testified in detail as to the services performed, it was admissible to ask another witness, who had testified that he was a civil engineer, and had heard the testimony as to the services, to give an estimate, from what he had heard of the testimony, what such services were reasonably worth, it being in effect a hypothetical question, based on a state of facts already shown.—Laut v. Rasines, 38 N. Y. Supplement Reporter, 975.

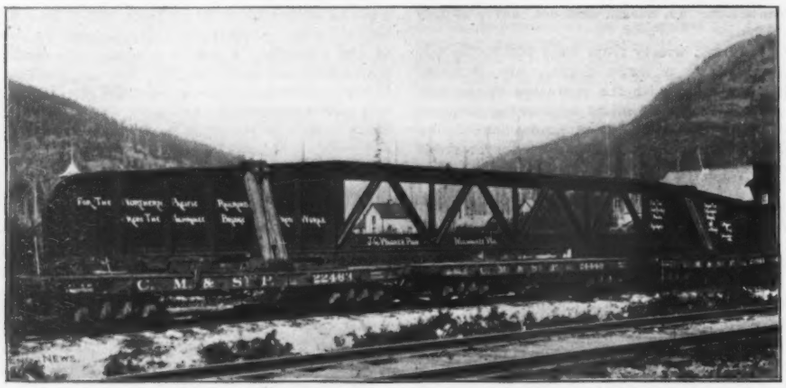


FIG. 1.—100-FT. THROUGH PLATE-LATTICE GIRDER FOR LIGHTNING CREEK BRIDGE, NO. PAC. RY.
K. E. Hilgard, Engineer of Bridges, No. Pac. Ry. Milwaukee Bridge & Iron Works, Contractors.

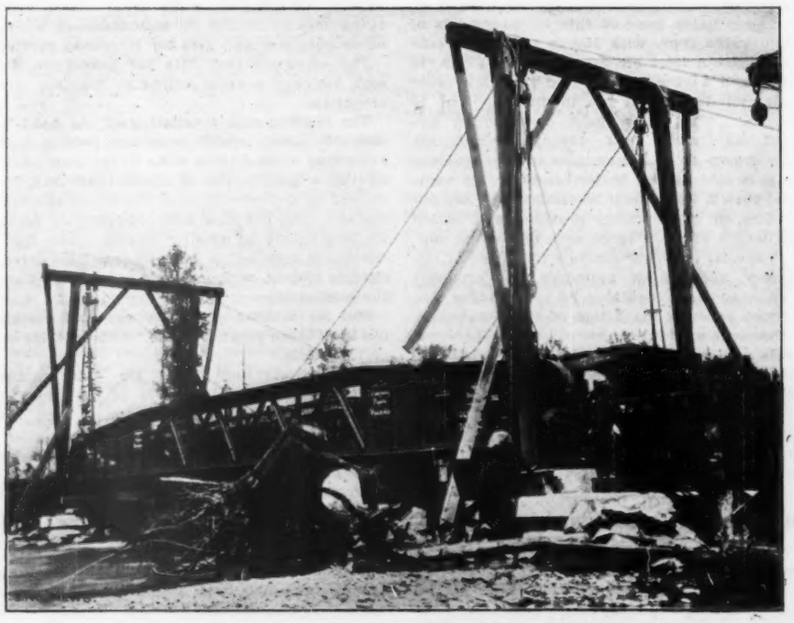


FIG. 3.—UNLOADING GIRDER FROM CARS ONTO MASONRY PIERS.

SOME WATER-HAMMER PHENOMENA AT THE FRESNO HYDRAULIC POWER PLANT.

The description of this plant would be incomplete without some special reference to its peculiar hydraulic features and the methods employed to overcome the difficulties which the abnormal conditions presented. The manipulation of water under heads of 500 ft. to 600 ft. is a task with which hydraulic engineers are familiar; but the successful control of a column 4,000 ft. long, 1,411 ft. in vertical height, and weighing about 317 tons, giving a pressure at the nozzle of 600 lbs. to the square inch, taxed severely the ingenuity of the San Joaquin engineers. Instead of water, they practically had to deal with a solid bar issuing from a nozzle 1¼ ins. in diameter, at a speed of over 9,000 ft. per minute. The usual method of construction was followed as with heads of water 500 ft. to 600 ft. high, and the gates and relief valves for such heads, somewhat magnified, were first used. They were found to be utterly inadequate, and have been practically abandoned. The gates are controlled at the power house by hydraulic rams. In opening the gates as at first designed, a fluctuation of 170 lbs. above and below the normal was brought about. That is to say, the pressure would first drop to 90 lbs. below normal, then rise to about 80 lbs. above, then sink to 75 lbs. below normal, and continue "diminuendo" until the normal pressure was reached. A similar phenomenon, but reversed in order, occurred when the gates were closed. Too wide a fluctuation militated against satisfactory operation, and after several trials the most expedient method was found in the opening of the gates very gradually, the operation occupying about thirty seconds. The fluctuation in pressure is now reduced to about 30 lbs. each way.

When the gates are opened the hills reverberate with a sound similar to that of a discharge of heavy artillery, which is apt to fill the visitor with a fear of impending collapse of the equipment. The explanation, however, is simple. When the gates are closed, some air freed from the water collects in the pipes. When opened, the water, filling the lower portion of the nozzle first, compresses the air in the upper portion and allows it to escape only in bubbles, which under the tremendous pressure, explode as they issue from the nozzle.

Some idea of the force of the water may be gathered from the experience in the wheel pit, which is built of solid granite masonry, and roofed over with planking. On turning on the water it first struck the buckets of the wheels; but instead of dropping to the tail race it followed the wheels to the plank ceiling, ran along it, and projected itself horizontally for a distance of nearly 60 ft. What water struck the bottom of the pit made its influence severely felt. In a day or two the concrete floor was demolished and the bed rock attacked, the water following the seams and even entering the power house. A piece of pipe 4 ft. long and about 14 ins. in diameter, and closed at one end, was then placed in line with the jet to provide a cushion against which the jet should strike. It only served, however, to reverse the direction of the water, which now, instead of running into the tail race, shot out upon the roof of the power house. The wheel pit was then dammed, so that a depth of about 3 ft. of water should lie in it. This, it was thought, would prevent the pipe just mentioned from being emptied, but resulted merely in increasing the amount of water projected on to the roof of the power house. The pipe was then filled with concrete, and the floor planked with 3-in. boards sheathed around the nozzle with steel plates ⅝-in. thick. The sand and small stones brought down in the pipe ate a hole through the steel planking in a very few hours.

Confronted with this problem, no better solution has been found than the supply of a plate of cast iron 1½-in. thick beneath the jets, renewed when necessary.

To attain perfect results in the operation of the generators they must run at an unvarying speed, and the

Fig. 2.—View Showing Method of Securing Girder on the Cars and the Swiveling Bolster.

question of water-wheel governors has not been the least important which the engineers have had to deal. Pelton differential deflecting nozzle governors are used as well as Lighthipe electric governors, both with excellent results. So far the installation has worked successfully.—(From an article in "The Engineer," London.)

STANDARD PLANS FOR 100-FT. THROUGH PLATE-LATTICE GIRDER BRIDGES; NO. PAC. RY.

(With two-page plate.)

For several years the Northern Pacific Ry. Co. has been gradually replacing on its main line a considerable number of the original timber or combination bridges, resting on crib and pile abutments and piers, by new permanent structures of wrought iron, and more recently of steel, resting on masonry and concrete substructures.

As the engineers were, in most cases, not obliged to adhere to the same lengths of spans that were used in the original structures, on account of the temporary character of the piers and abutments of the old bridges, it was found advantageous with the new structures to adopt certain fixed lengths of spans which could be duplicated as often as possible, if consistent with the greatest economy regarding lengths and number of spans required to give the necessary waterway at each crossing.

For all spans up to 100 ft. in length plate girders were at first considered preferable under favorable or even ordinary circumstances. Later, however, a combination plate-lattice girder design was made, and a number of spans of this type were built last year, and are again contracted for to be built this season. The first "plate-lattice" girder was adopted in the summer of 1895 in a design for a 100-ft. shallow floor through-span across "Lightning Creek" in Idaho. The span was built by the Milwaukee Bridge & Iron Works, and the girders were shipped in full length completely riveted up in the shop on three cars, as shown in Fig. 1. The permanent track could not be raised sufficiently to preclude the possibility of water flowing over the rails in case of an extraordinary "high water," although a special shallow floor and a consequent larger number of panels had been adopted for the span. A full web-plate girder in such a case would have acted like a dam, and for this reason was discarded.

Besides the above consideration the following advantages were found to be in favor of the plate-lattice girder:

1. Greater ease in taking care of shear stresses at and near ends by a full web, instead of by heavy web members of a latticed girder, requiring clumsy connections.

2. Greater ease in riveting web member connections as compared with riveting vertical stiffeners and (in case of through spans) of riveting floor beam connections to a full web in main girder in shops where no riveting machines with deep gaps are available, so as to obviate hand riveting in web throughout between flanges in the case of the 100-ft. spans.

3. Saving of about 1,500 lbs. in weight per girder, and a corresponding saving in cost over a full-web plate girder designed under the same specifications.

The comparative pound prices bid by most of the bridge shops were the same for a "plate-lattice" girder or "all-plate" girder design; or even slightly lower (on the part of one of the best equipped shops), for the former, based on equal lengths of spans and designed under the same specifications.

The present practice of the Northern Pacific Ry., with respect to the type of bridge to be used for various spans and the general features of design which are observed, are stated to us as follows:

For all spans up to a length of 80 ft., inclusive, plate girders are adopted; from 85 to 105 ft., inclusive, plate or lattice girders; from 110 to 125 ft., inclusive, lattice girders or semi-pin-connected trusses; from 130 ft. up, regular pin-connected trusses.

All counters or adjustable members are omitted wherever practicable. All transverse and lateral bracings or struts, and longitudinal bracing in trestle towers, consist of angles or channels singly or laced, and their connections are rigidly riveted wherever possible. All rivet holes in steel are specified to be reamed.

The girders for the Lightning Creek bridge weighed 54,000 lbs. each and measured 102 ft. over all. The weight of the entire span was 160,000 lbs. The span was built of soft steel with medium steel flange angles and cover plates and the rivet holes were reamed. The rolling load for which it is designed is a heavy 116-ton consolidation locomotive. Fig. 2 shows the manner of supporting the girder on the car by swivelling plates and the braces by which it was secured from overturning. Fig. 3 shows a girder being unloaded from the cars on which it was shipped and lowered onto the masonry piers which are to carry it. The contractors for the erection of the span were Messrs. Kelly & Atkinson, of Chicago.

Upon our inset sheet is shown the detailed standard plans of the Northern Pacific Ry. Co. for 100-ft. through plate-lattice girders and Fig. 4 shows several types of such girders. These plans, as well as the entire set of standard plans for iron and steel superstructures of the Northern Pacific Ry. Co., composing to date about 25 different deck and through spans, from 20 ft. to 180 ft. in length, were designed in detail by Mr. K. E. Hilgard, M. Am. Soc. C. E., Bridge Engineer of the company. We are indebted to Mr. Hilgard for the privilege of reproducing his drawings upon our inset sheet and for Fig. 4 shown herewith, as also for the photographs from which other engravings are prepared.

In our next issue we shall show some further examples of these standard plans with some further account of the practice of the Northern Pacific Co. as developed by Mr. Hilgard in the preparation of its standard bridge drawings, etc. At present we may remark that Mr. Hilgard's drawings were so unusually well executed that we were able to reproduce them directly upon our inset sheet, something we are able to do with very few drawings which come to this office.

It should be noted that since the plans were made which are reproduced on our inset sheet, the 6 × 8-in. angles in the flanges were changed and 6 × 6-in. angles substituted on account of the high premium which is now being charged on 6 × 8-in. angles. To meet this change the sections of cover plates were increased correspondingly and the number of rivets in the flanges was also considerably increased.

Similar changes, as, for instance, the substitution of rolled channels in the place of channel sections built up of plates and angles in truss spans,

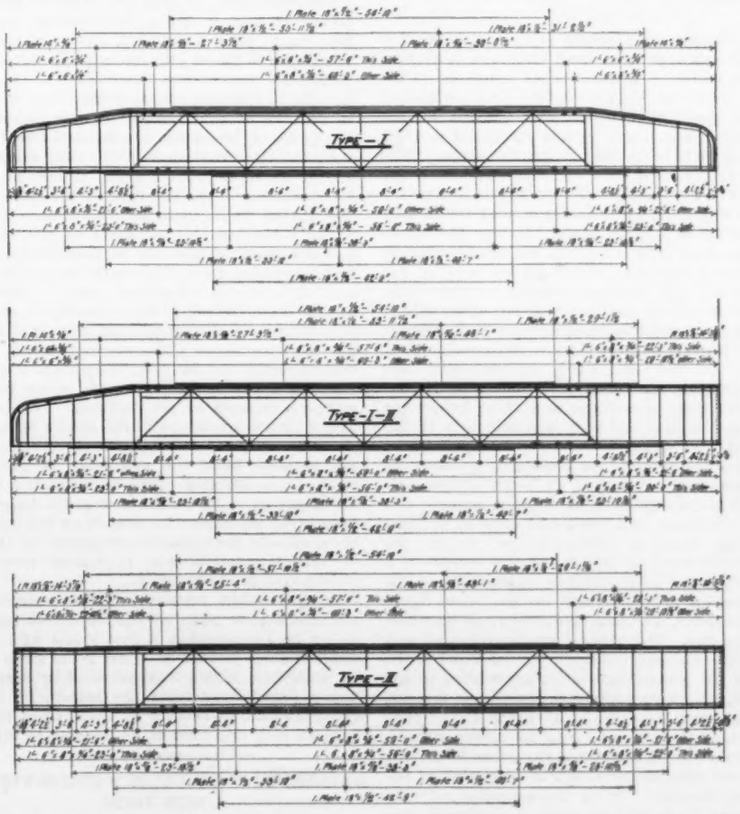


FIG. 4.—DIAGRAMS SHOWING STANDARD TYPES OF 100-FT. THROUGH PLATE-LATTICE GIRDERS, NO. PAC. RY.

are, as a rule, willingly conceded to the manufacturer if found desirable, owing to the condition of the steel market, as far as thereby the general character of the design is not changed and the aim of the details not defeated.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY.

D. McN. STAUFFER, Vice-President, } - - - EDITORS.
CHARLES WHITING BAKER, Secretary, }
GEO. H. FROST, President, } - - - - BUSINESS MANAGERS.
F. P. BURT, Treasurer, }
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, } ASSOCIATE
CHAS. S. HILL, A. B. GILBERT, } EDITORS.
CHAS. W. REINHARDT, - - - - - CHIEF DRAFTSMAN.
ALFRED E. KORNFELD, New York, } - ADVERTISING
F. A. PECKHAM, Chicago, } REPRESENTATIVES.

PUBLICATION OFFICE, ST. PAUL BUILDING, NEW YORK.
WESTERN OFFICE, MONADNOCK BLOCK, CHICAGO.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The proposed amendments to the constitution of the American Society of Civil Engineers were very fully discussed by representative members of the Society at the Quebec Convention, and the revised form of amendment which was adopted by the meeting and which will be now submitted to letter ballot, seems to meet fully all requirements. Under the present constitution all Past-Presidents are members of the Board of Direction, and this makes so large a number of members of that Board that it is sometimes difficult to get together the requisite number to form a quorum for the transaction of important business, which cannot well be left over for the next monthly meeting. Besides this, there are objections that membership of the Board involves more financial and other responsibilities than all Past-Presidents care to assume for their lifetime. On the other hand, the men who have been Presidents have held other offices in the Society, and their experience and their knowledge of precedents, etc., are very valuable aids in the administration of the Society. If the amendment is adopted, the nominee for President, in accepting the nomination, will accept six years of responsible work in the affairs of the Society, namely, one year as President, and five years after as a member of the Board of Direction, as under the amended constitution this Board will consist of a President, four Vice-Presidents, eighteen Directors, a Secretary, a Treasurer, and the five latest living Past Presidents, who shall continue to be members of the Society. The text of the amendment and notes of the discussion thereon will be found in the report of the proceedings of the convention in another column. Two additional features of interest are: First, that the votes of all living Past-Presidents (excepting any who may be incapacitated), are required for the election of Honorary Members; and, second, that the Secretary is a member of the Board of Direction. With the adoption of the amendment there will be greater ease and less friction in the management of the affairs of the Society, and no diminution in the protection of the Society's interests.

"Should Generating Plant be Mounted on Springs?" was the title of a paper which was read by Mr. James Swinburne, M. Inst. C. E., at the recent General Conference in London of the Institution of Civil Engineers. The following extracts will give the author's idea:

The question is, if the bedplate of an engine wants to move, why should it not have free play? As far as the engine goes, a little thought will show that all its parts are subjected to smaller stresses if the bedplate is free to move. An engine will, therefore, wear longer if it is allowed to move its bedplate. As to the foundations, if the bedplate is allowed to move, no foundations to speak of are needed, and there is no vibration communicated to the ground. The idea of mounting engines and dynamos on springs was mooted by the writer in 1892. Mr. W. W. Beaumont has done a great deal of work on the subject, especially in connection with flour-mills. He has introduced his "vibromotor" principle. This principle is simple. If gear wants to wobble, let it wobble.

The discussion brought out numerous instances where vibrations of buildings had been stopped by mounting engines on felt. It was pointed out that if springs were used some form of dashpot must also be used to prevent the oscillations of the structure synchronizing with the natural rate of vibrations of the springs. Some experience of one of the speakers, Mr. Crompton, was entirely unfavorable to the use of resilient foundations. The engine in an electric-lighting station in Vienna, mounted on an asphalt base 8 ins. thick, gave so much vibration that it had to be reset on a single solid block foundation. Gas engines on a springy foundation consisting of a pile of brushwood gave more annoyance by swinging of the pipes and breaking connections than if they had been mounted on a solid block.

Some American engineers might have contributed to the discussion some additional information concerning methods of preventing vibrations. Their plan is just the opposite of Mr. Swinburne's in respect to the foundation. Where he says that "no foundations to speak of are needed," they would put in a massive foundation to which the engine is rigidly secured, but they would detach the engine foundation from the foundations and walls of the building containing it by placing underneath and around the engine foundation layers of felt or other compressible substance. The theory upon which this system of preventing vibrations is based may be thus explained: If a horizontal engine were unattached to a foundation the unbalanced forces would cause it to move to and fro at every stroke of the piston. The amplitude of the motion or vibration would depend upon the relative values of the total mass moved and of the force producing the movement. For a given moving force the greater the mass moved the smaller the amount of movement. Hence by firmly attaching the bed plate of the engine to a heavy mass of masonry or foundation, making this foundation part of the mass to be moved, the amplitude of the vibrations may be made very small. Nevertheless, if such foundation should be in contact with the foundation or wall of a building the vibrations, although very small, will be transmitted to the building and give to it a tremor which is apt to be an annoyance, to say the least, to the occupants of the building. In case the period of the vibrations of the engine should synchronize with the natural period of vibration of the building itself the amplitude of the vibrations of the building might be multiplied to such an extent as to be a source of great danger. By embedding the engine foundation on felt the vibrations, already diminished in amplitude by the mass of this foundation, are prevented from being transmitted to the building.

An interesting instance of the prevention of vibrations took place at the Spreckels sugar refinery in Philadelphia a few years ago. Some small engines located on upper floors gave trouble by vibrations, which was corrected by suspending heavy foundations from the bottom of the engines, so that in looking at them from the floor beneath they appeared to be hanging in the air.

DIFFICULTIES IN THE USE OF WATER POWER UNDER HIGH HEADS.

Fifteen or twenty years ago the development of water power in this country was almost at a standstill. Steam power had become so cheap in most sections of the country that, except for industries requiring a large amount of power, it was generally cheaper to "take the power to the work" than to take the work to the power. The development of new water powers was confined to the newer sections of the country, or to special locations, where such industries as papermaking, requiring large amount of cheap power, were being extended.

But the development of electric lighting, electric railways and the transmission of electric currents for power and lighting over long distances has created a new and enormous market for water power. It is safe to say that the near future will see every available water power in the country utilized, at least, to a sufficient degree to supply the demands for electric current for lighting, railway and power purposes of the towns and cities within a radius of 10 to 50 miles.

And this development of water power will not be along such limited lines as prevailed with the "millwrights" of a half century ago. There will be a more general use of small streams with great fall than was customary then. On the Pacific Coast and in the Rocky Mountain region a great deal has already been done in this direction.

In an article in another column of this issue Mr. John Richards, of San Francisco, gives a brief account of some of the difficulties which have been experienced on the Pacific Coast in the development of water power under great heads. The subject is of such importance, in view of the present great extension in the use of water power and also on account of the demand for a more close regulation of the speed of water wheels under variable loads than has been previously possible, that we have thought it worth while to supplement Mr. Richards' paper with an editorial discussion of the problems involved. To get a clear idea of just what these problems are, let us take a practical example. Suppose we have a pipe 12 ins. in diameter and 100 ft. long delivering water to a water motor. Suppose the pipe is vertical, so that the static head is also 100 ft. and that the water is flowing through it at the rate of 6 ft. per second to supply the nozzle or contracted orifice at the lower end through which it issues against the buckets of a wheel. The weight of water in that 100 ft. of pipe will be 4,900 lbs., and its velocity of 6 ft. per second is equivalent to nearly 4 miles an hour, about the rate of a rapid walker. The energy stored in this moving mass of water is

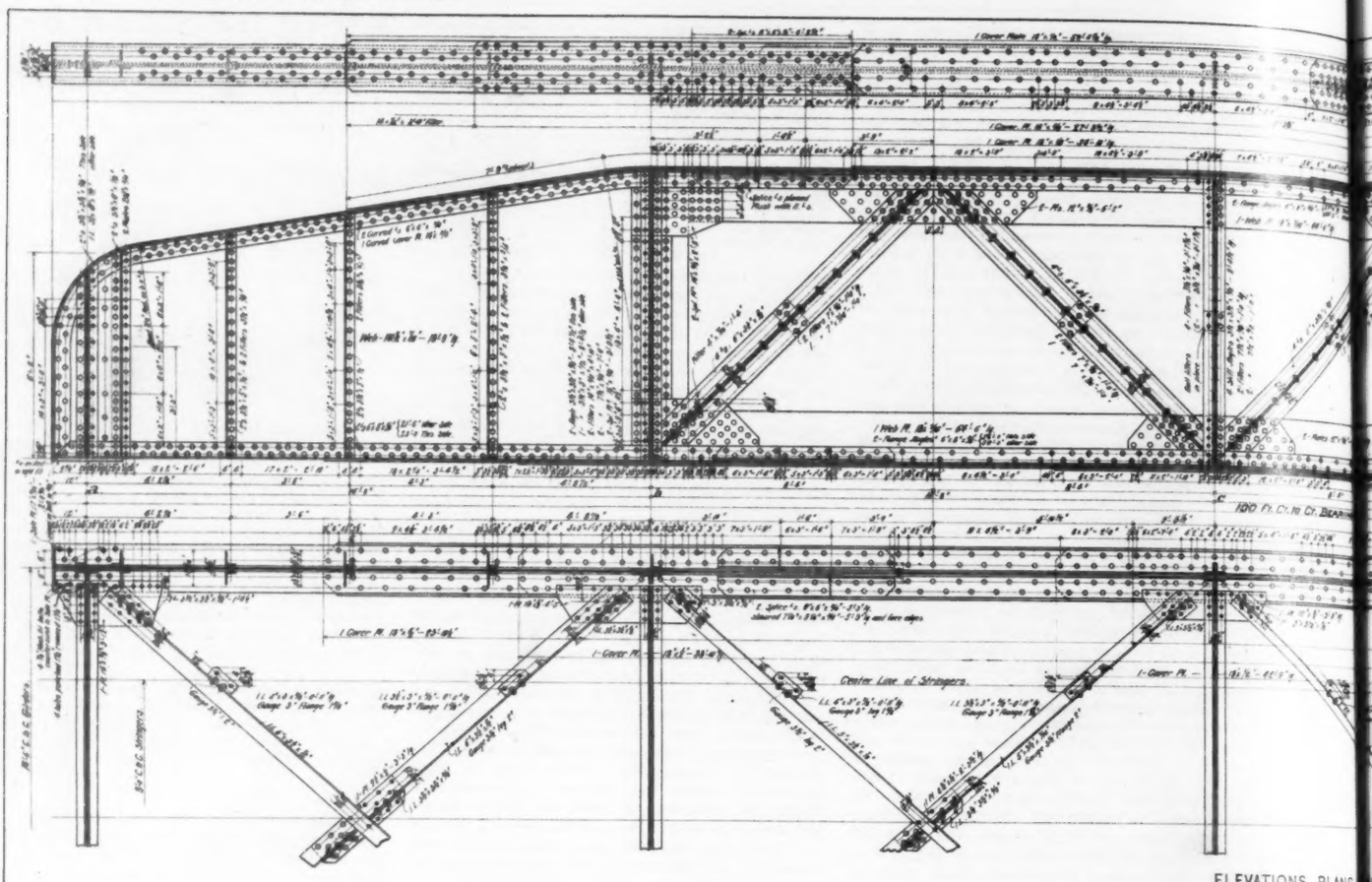
$$W\frac{v^2}{2g} = 2{,}750 \text{ ft. lbs.}$$

At this velocity the pipe will deliver 277 cu. ft. per minute, weighing 14,790 lbs.; and as the head (neglecting loss by friction) is 100 ft., the total useful effect will be 1,479,000 ft. lbs. per minute. Dividing this quantity by 33,000 we have the horse power of the fall at 45 HP.

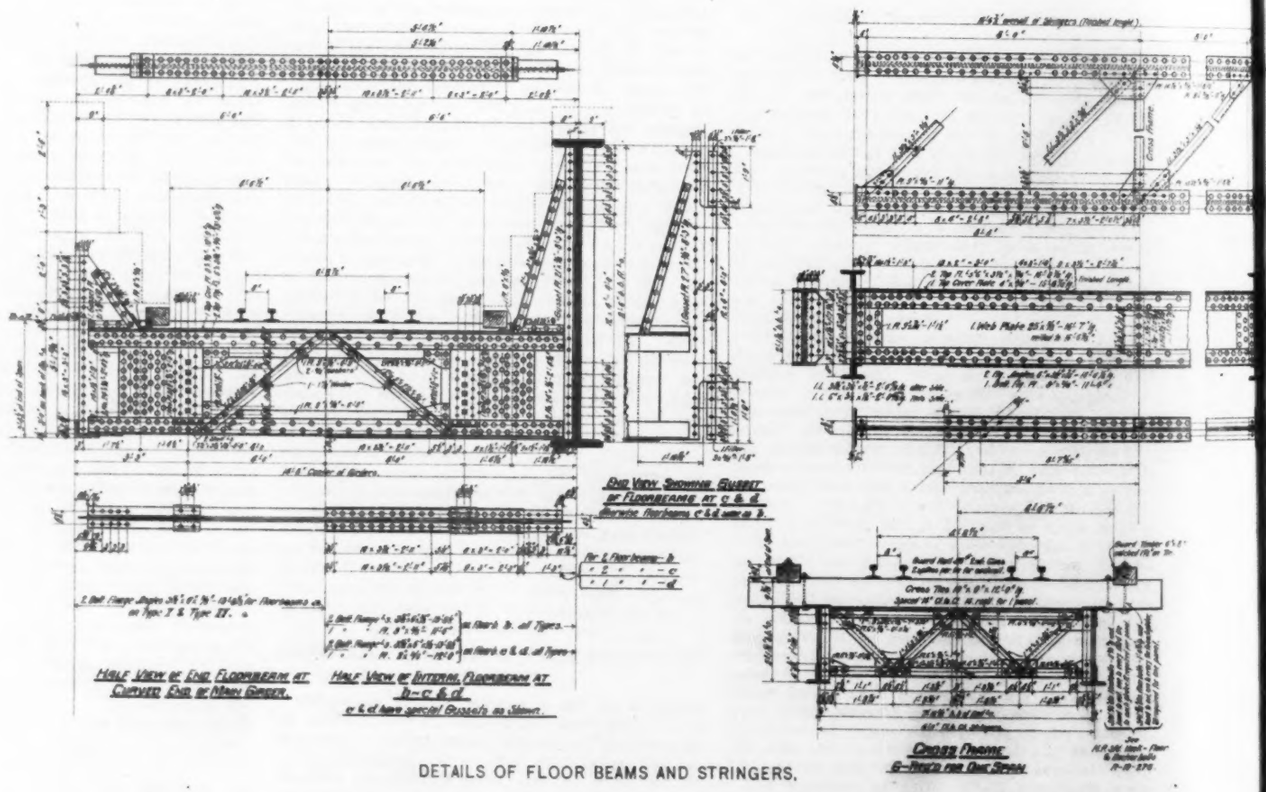
Suppose this 45 HP. is the full load of the motor. As every one knows, there is hardly any service for which either steam engines or water wheels are used in which the load is uniform; but whatever the variation in the load, the speed must be kept uniform, within very close limits. This is especially true in driving dynamos for generating electricity, and it is in this work also that the greatest and most sudden variations in the load are likely to occur.

Returning to the practical example we are studying, suppose that the load on the motor is reduced to 15 HP. That means (neglecting the friction of the motor itself) that only one-third of the amount of water should be applied to the wheel. Its velocity in the pipe will then be 2 ft. per second instead of 6 ft., and the energy of the mass of water in the pipe will be only one-ninth as great, since this varies with the square of the velocity. That is, it will be only 305 ft. lbs. instead of 2,750 ft. lbs., a decrease of 2,445 ft. lbs. Now, something must be done with this 2,445 ft. lbs. in order to reduce the velocity of the water to the extent we have supposed. It is certain to expend itself somewhere. Were we instantly to close the orifice, it would expend itself in tearing the pipe open. If we close the orifice only partially, the inertia of the water immediately raises the pressure at the lower end of the pipe and the water issues with greater velocity than before. This added velocity represents additional work, the source of which is the inertia of the water in the pipe, and as the inertia is gradually absorbed, the velocity falls back to its former amount.

The inventors of water wheel governors have been exerting themselves in every way possible to secure quick moving valves and valve motions in their attempt to secure close regulation of



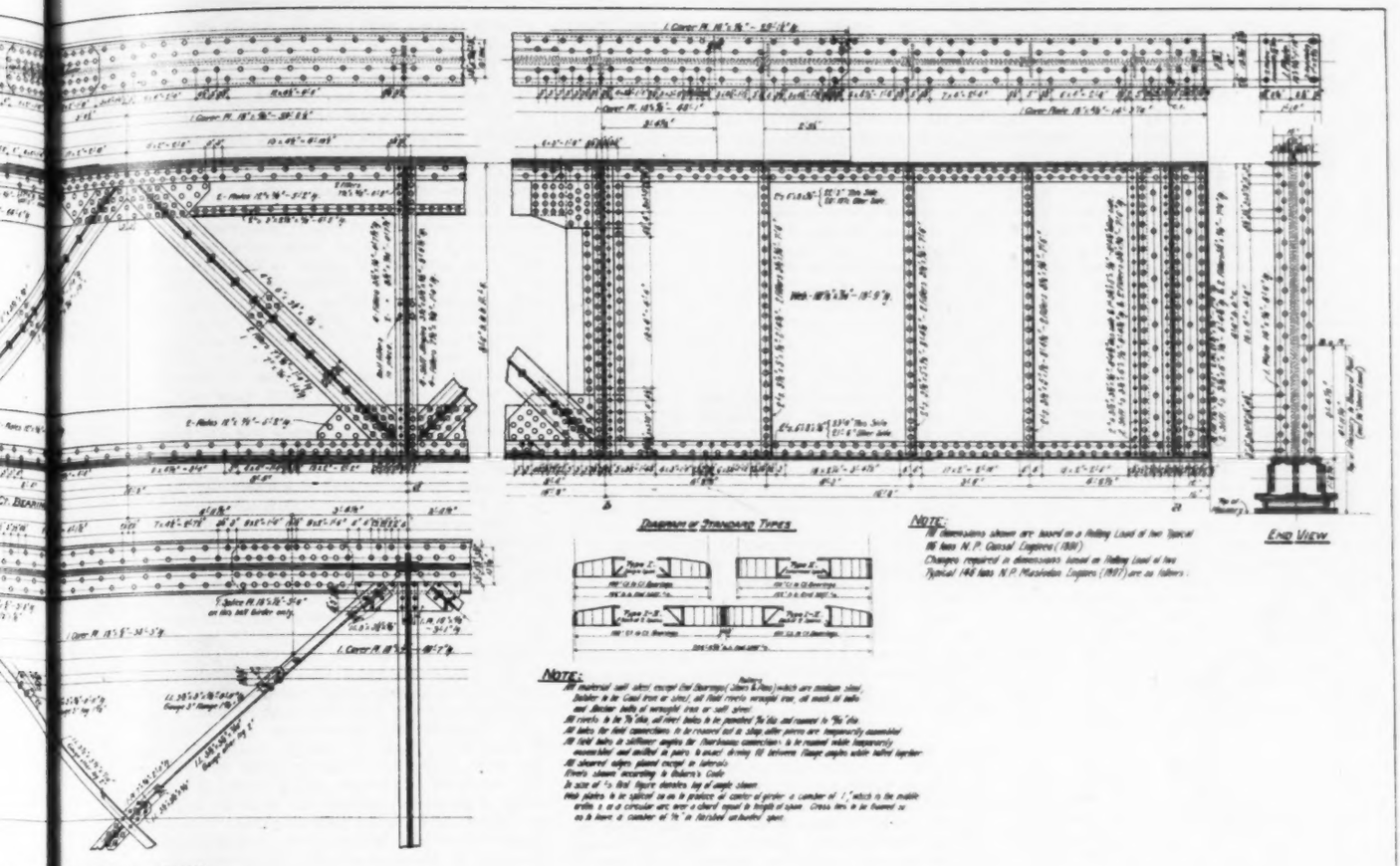
ELEVATIONS, PLANS AND SEC


End View Showing Gusset of Floorbeams at C & d.
Half View of End Floorbeam at Curved End of Main Girder.
Half View of Interm. Floorbeam at b—c. & d.
Cross Frame.

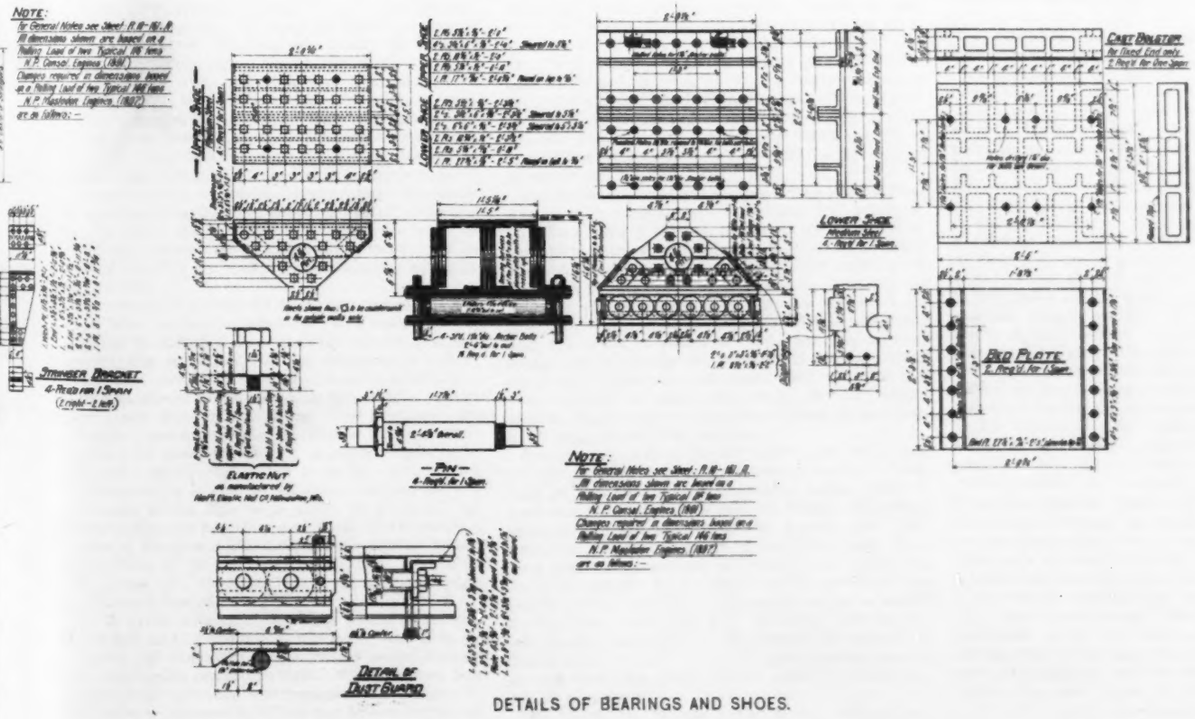
DETAILS OF FLOOR BEAMS AND STRINGERS.

STANDARD 100 FT. THROUGH PLATE-LATTICE

K. E. Hilgard, M. Am. Soc. C. E., Engineer of Bridges;



PLANS AND SECTIONAL VIEWS.



DETAILS OF BEARINGS AND SHOES.

E-LATTICE GIRDER BRIDGES, NO. PAC. RY.

E. H. McHenry, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART & SONS, LITH., 90 VESEY ST., N. Y.

speed. We do not say that they are not working in the right direction, but let us suppose that some one should really devise a governor so perfect that at the same instant the load on the wheel was reduced to one-third, it would close the gates admitting the water to the wheel to one-third their former opening. Let us suppose that this movement is actually instantaneous, and see what would happen in that instant. In the first place it is clear that the water in the pipe could not change its old velocity of 6 ft. per second instantaneously, hence for an instant the same amount as before must be delivered through an orifice one-third as large, or at three times the velocity. The old velocity was that due to a static head of 100 ft., or 80 ft. per second. The new velocity will be 240 ft. per second, which corresponds to a head of 900 ft., or a pressure of 391 ft. per sq. inch. As the same amount of water is issuing as before, but under nine times the head, the work done on the wheel will be nine times as great. Of course, this high pressure on the pipe line and increased work on the wheel are merely for the instant. At the same instant the inertia of the water in the pipe begins to be absorbed the velocity begins to fall off, and with it, of course, the quantity of water delivered to the wheel. If the velocity and delivery which we found above were to remain constant, it would be only 1-82 of a second before the 2,445 ft. lbs. of inertia, which appear when the velocity of the water in the pipe is changed from 6 ft. to 2 ft. per second, would be absorbed.

Of course, the supposition we have made is not a practical possibility. No valve can be opened or shut instantaneously, and as a matter of fact, in all water wheel governors the large size of the valves makes their closing very slow as compared with the valves of a steam engine, for example. The above discussion shows, however, that even if this could be overcome, the difficulties in close regulation of water wheels would not be at an end. The first effect of the partial closure of a water wheel gate taking its flow from a long conduit is an actual increase in the work done on the wheel, and conversely, if with an increase of load the gate is slightly opened, the first instantaneous effect is to reduce instead of increase the work done on the wheel.

These are correctly spoken of as instantaneous effects. In the case of pipes of moderate length they may never become practically noticeable. With very long pipes, in which water flows at high velocity, they may cause a vast amount of trouble if they are not foreseen and provided for.

The practical rules which may be easily deduced from the foregoing discussion are two. Since in every water power plant it is desired to reduce the difficulties from irregular governing of the motors and excessive pressures on the pipes as much as possible, the engineer should endeavor (a) to make the length of the pressure pipe as small as possible; (b) to make the velocity in it as low as possible by making the diameter as large as possible.

Of course, in almost all cases the increased cost of a pipe of larger diameter will make it not feasible to increase the diameter merely for this reason, but it is well for the engineer to understand that this is a desirable end to be attained.

In the direction of reducing the length of the pipe much more can be done. The engineer, for example, can often take his choice between running a pipe from the source of supply directly to the place where the power is to be utilized and running either a pipe or an open channel on the hydraulic grade line to a point as near to the power house as possible, and from there running a pipe to the power house on a steep grade. When this choice is offered to an engineer, the plan that gives the shortest length of pressure pipe should be adopted.

It is often supposed that the pressure at the lower end of the conduit is the important item as respects the difficulty in governing water wheels, but this is not really the case. The pressure has a practical influence as respects the weight of the gates to be moved, but so far as the inertia of the water is concerned, which has to be taken care of when a change in the load on the wheel occurs, it is the length of the pipe and not the head of water at the exit that is the important factor.

A very good illustration of correct design is the conduit of the Pioneer Power Co., which is illustrated and described in this issue. The total length of this conduit is a little less than 6 miles and its diameter is 6 ft. The total weight of water contained in the pipe is, therefore, more than 25,000 tons, and its kinetic energy when the water is flowing at the rate of 250 cu. ft. per second, for which the conduit is designed, is as great as that of a railway freight train made up of a consolidation locomotive and 30 loaded cars and running at the rate of 40 miles per hour.

But in building the conduit it was not made a continuous line of pipe. The upper section is laid approximately on the hydraulic grade line, so that the total fall in a distance of five miles is practically utilized in overcoming the friction of the water in the pipe. It is the steep descent in the last ⅞ mile of steel pipe that is utilized in producing power, and at the head of this grade, where the junction of the upper section and lower section of the conduit is made, there is an open-topped stand pipe. In case the flow of water in the conduit is checked, the inertia of the water in the upper section is absorbed in raising the water in this stand pipe and causing it to overflow, and cannot affect the pressure in the pipe at the power house, save by the slight increase in static head, due to raising the normal level in the stand pipe.

It will be seen, however, that even with the inertia of the upper section thus taken care of, the water in the lower section, ⅞ mile long, has something like 6,000 ft. tons, or 12,000,000 ft. lbs. of kinetic energy, which is quite difficult enough to take care of. Thus suppose the demand for power falls off one-fourth; if it becomes necessary to reduce the rate of flow in the conduit to correspond to this, we must in some way dispose of nearly 7,000,000 ft. lbs. of the inertia possessed by the water flowing in the pipe.

Let us examine the different methods proposed or possible for solving this problem. The simplest way, doubtless, is to maintain a uniform flow of water in the conduit, and govern the wheels by deflecting the nozzles slightly when the demand for power falls off. The objection to this is that it is wasteful of water. The amount of water used is always equal to the maximum load.

A method which gives good results in the case of closed turbines is to govern the flow by throttling the escape from the wheel. It will be seen that the inertia which has to be disposed of when the flow in the supply conduit is checked is, in this case, not applied to the wheel at all, but is expended in giving velocity to the water escaping from the wheel. But this method is not applicable at all to open bucket or impulse wheels, and it has the disadvantage that, except when the wheel is working at full load, a considerable amount of power is wasted.

The attachment of air vessels to the supply conduit is a common mode of solving the problem, but the difficulty is that, unless an air vessel is of enormous size, it can absorb only a very small amount of power under the conditions existing in a water power plant. It must be remembered that an air vessel operates only by the increase in pressure in the conduit to which it is attached, and the work it stores is only that required to compress the volume of air which it contains from its initial to its final pressure. But to fulfil the requirements of good governing of the water wheels, the pressure cannot be allowed to increase very much above the normal.

The proper duty of an air vessel (and its value for this purpose is unquestionably great) is to take care of the inertia of the flowing water when a gate in a long conduit is entirely closed. As every experienced hydraulic engineer knows, the very greatest care is necessary in closing a gate in a long conduit to prevent a "water ram" that will burst the pipes. In a conduit under pressure, the metal of the pipe has very small power to resist shock. But when the gate is closed slowly, the velocity is reduced until the amount of energy in the flowing conduit, which the air chamber has to absorb when the escape of the water is finally cut off, is very small.

Mr. Richards, in his paper above referred to, states that when the flow in a long conduit is suddenly checked, pulsations of pressure are set up. The foregoing study of the actions of water under such conditions makes one cause of these pulsations plain. Suppose we have a water wheel with a governor which operates by throttling the flow of water to the wheel, the almost invariable practice. Suppose the load on this wheel is reduced one-fourth. The speed increases and the governor begins to close the nozzle; this raises the pressure in the pipe and, as we have already seen, actually increases for a moment the work done by the jet on the wheel. The effect of this on the already underloaded wheel is to increase its speed still more, causing a further movement of the governor, and another increase in pressure. The net result of the action is to cause the governor to close the nozzle until the flow is reduced below what is necessary for the load on the wheel. Then the speed of the wheel is reduced below the normal and the governor begins to open the throttle valve, which causes a drop of pressure in the conduit, and the same cycle is repeated until an equilibrium is finally reached. These occurrences, of course, take place with great rapidity, and constitute that rythmic pulsation which is described by Mr. Richards and also by the writer who describes the Fresno power plant in another column.

The reader who has followed the above discussion can now form an intelligent opinion as to the merit of the device of Mr. E. S. Cobb, described in Mr. Richards' paper. It appears to us to be an excellent device, and likely to prove effective if properly designed. We desire to call especial attention to the waste valve of this device, which appears to us likely to prove the best method for controlling the flow in long pipes and solving the difficulties in governing the speed of wheels, and in controlling the pulsations and shocks in the pipe to which we have referred. Such relief valves should be proportioned to the size of the pipe they control, and should be located as near to the nozzle of the pipe as practicable. They should be so loaded as to open automatically when the pressure in the conduit rises somewhat above the normal working pressure, and would then act to prevent the further increase of pressure in the pipe. The water wasted through them would be comparatively small in amount and would furnish, we believe, the cheapest and simplest way of taking care of the energy that appears when the velocity of flow in the conduit is checked.

In many cases it is true that to secure good governing these valves would have to open at a pressure lower than that due to the static head on the pipe. But it would be a simple matter in any such case to make part of their load removable, so that when it is desired to entirely shut off the flow there may not be a waste of water through these valves.

In conclusion, the reader who has carefully followed the above discussion cannot fail to have perceived that to secure good governing in hydraulic motors working under high pressures, sufficient time is an absolute essential. We cannot suddenly change the rate of flow in a long conduit, but we can do so gradually without difficulty, and the best thing that can be done when a water wheel must be driven from such a conduit to carry a rapidly varying load is to furnish a reservoir of energy in the shape of a heavy fly wheel on the water wheel shaft. By this means the changes in the speed of the water wheel may be made so gradual that a similar variation of flow can be made in the conduit without causing either excessive variations of pressure or waste of water.

While all our foregoing discussion has referred solely to the problems encountered when water power is developed from long conduits, the use of fly wheels in any water power plant will be found to be of very great advantage. While the engineer has no difficulties with pulsation or wated hammer to encounter when a turbine takes a supply directly from a fore-bay, the difficulty in quickly moving the gates of the wheel when sudden changes of load occur makes the steadying effect of a fly wheel of great value here as well.

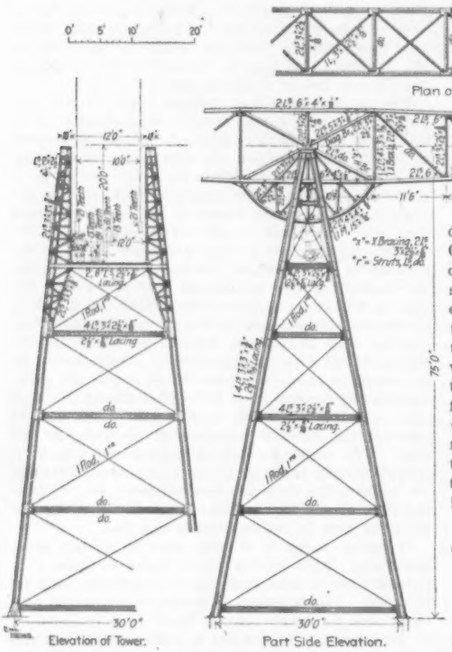
Cast iron is very cheap and the maintenance of a good many tons of it in the shape of fly wheels is a very small item. We believe the engineer entrusted with the design of hydraulic power plants who is liberal in his provision of fly wheels will find them the best insurance against difficulties of the class which we have described.

A GIANT SEE-SAW, FOR THE TENNESSEE CENTENNIAL EXPOSITION, NASHVILLE, TENN.

By Gilbert P. Coleman.

An engineering novelty in the shape of a gigantic see-saw, which has been set up on the grounds of the Tennessee Centennial Exposition at Nash-

ville, Tenn., has just been completed by the Schultz Bridge & Iron Co., of Pittsburg, Pa. It is the purpose of the promoters, chief among whom is Mr. C. H. de Zevallos, of Nashville, to make the see-saw as prominent a part of the exposition as was the Ferris wheel at Chicago. Indeed, it is said that a project of a similar kind was at first contemplated for the Columbian Exposition, but was abandoned in favor of Mr. Ferris's notable device, which, it was supposed, would prove a greater attraction. The original size of the see-saw, however, has been considerably enlarged, and in its present proportions it will no doubt prove a worthy successor to the wheel. The structure is built entirely of steel, and the plans were made and designs furnished by Mr. A. J. Dyer, civil engineer, of Nashville, Tenn.



GIANT SEE-SAW AT THE TENNESSEE CENTENNIAL EXPOSITION, NASHVILLE, TENN.

A. J. Dyer, Civil Engineer, Nashville, Tenn., Designer; Schultz Bridge & Iron Co., Pittsburg, Pa., Builders.

The support for the cross-beam, or see-saw proper, as will be seen from the drawing, consists of a central tower of steel, with four legs covering an area of 30 ft. square at the base and meeting at the top. The perpendicular height of the tower from the ground to the pin on which the cross beam swings is 75 ft. The cross beam measures 160 ft. from end to end and is built entirely of steel. Like the central tower, it is rectangular in section, varying from 11 ft. 3 ins. at the center, to 6 ft. at the ends of the arms. It is swung on its axis by means of two parallel segmental racks, each of which is 25 ft. in length. The pinions operated by the motor engage with these operating racks to produce the see-saw motion of the beam. This motor was built by the Triangle Electric Co., of Cincinnati, O., and the remaining machinery by the Central Iron Works, of Quincy, Ill. One of the most striking features about the whole contrivance is the fact that the motive power is located at the top of the structure.

At each end of the cross beam is suspended a car capable of holding from 12 to 15 persons. These cars are swung from steel shafts 6 ins. in diameter. The cars are 7½ ft. wide by 9 ft. in length, and are constructed wholly of cast-steel.

It will be observed that the total elevation of the see-saw will be very nearly 180 ft., including the 25 ft. elevation of the terrace. This is nearly as high as some of New York's sky-scraper office buildings and hotels. The Waldorf, for example, measures just 182 ft. from roof to ground. From this altitude an extensive view of the surrounding country can be had, including the old forts and battlefield of Nashville, the famous Belle-Meade stock farm, and the "Hermitage," the old manor home of ex-president Andrew Jackson.

The structure will be erected at an advantageous point on "Vanity Fair," which is the name given by the promoters of the Exposition to the thoroughfare which corresponds to what was known at Chicago as the Midway Plaisance. It is confidently expected that the venture will prove fully as successful from a financial point of view as the Ferris wheel, and when we take into consideration the extraordinary ambition which possesses the souls of human beings to attain to great heights above the earth, there is reason to believe that this confidence is not without good foundation. The president of the company, Mr. C. H. de Zevallos, states that the capital stock of $25,000 has been subscribed, and that the sompany has obtained a very desirable franchise from the exposition authorities. The device has been duly patented, though no immediate competition is anticipated. The contracts provided that the structure should be completed and erected by May 1, which was the date of the opening of the exposition. A band of music will be stationed at the foot of the structure in a pavilion, and a "ride" will consist of a hoist into the ethereal regions and return, with a brief sojourn at the highest elevation to allow the voyagers an opportunity to view the surrounding country, while the alternate car is being emptied and refilled.

WATER-RAM IN THE SUPPLY MAINS OF HYDRAULIC POWER PLANTS.

By John Richards.

On the Pacific Coast where pipe lines under heavy pressure are often miles in length, and sustain pressures from 100 to 300 lbs. per sq. in., or even more, the subject of water-ram becomes of great importance, especially where the consumption and flow are variable.

The common conception of water is based upon its visible mobility, and it is hard to conceive of it as a solid, which, when confined, is as inelastic as steel, and whose momentum in a long pipe is the same as that of a bar of iron of the same length and weight.

These long pipes contain sometimes hundreds of tons of water, the movement of which is more difficult to control than that of a ship of equal weight moving in the water.

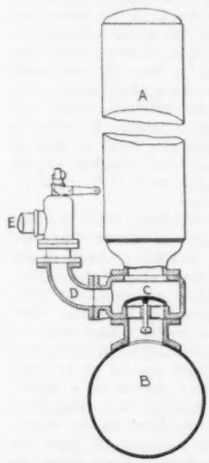
For constant supply there is but little difficulty from water-ram, but when a considerable part of the water under high heads is employed in driving dynamos and the rate of flow is subject to sudden and extreme fluctuation, water-ram has become a serious fact, and gives rise to phenomena first made known to the world, in practical form, by Riedler's "Versuche auf Pumpen."

Observations made at the Comstock Mines about 16 years ago by Mr. William B. Eckart, and the expensive experiments of the Risdon Iron Works of San Francisco, in dealing with pressures of 600 to 700 lbs. per sq. in., would, if published, furnish some startling facts in respect to water-ram. At the Comstock Mines in Nevada, where enormous heads were dealt with, 10-in. pipes with walls 2½ ins. thick were torn to pieces as if made of paper, and the main uptakes became safe only when provided with a nearly continuous parallel line of air vessels. This experience preceded the work of Riedler, and except a paper of Mr. Joseph Moore, read before the Association of Engineers in Glasgow, a year or two later, no account of these experiments and work has found its way into hydraulic literature.

When the velocity of flow is even slightly checked in these long lines of high-pressure pipes provided with common air vessels, rythmic pulsations of varying intensity are set up, producing variations of pressure extraordinary in amount. Thus the regulation of the speed of water-wheels becomes impossible within the limits demanded in the generation of electric current. If the water is shut off in proportion to the changes of the load, pulsations are set up which produce periods of racing with the wheels, and abnormal strains in the pipes and connected vessels.

The expedients which have been adopted to obviate these troubles have been to deflect the jets of water, or a part of them, so as to miss the buckets or floats of the water-wheels; to use large air vessels and to place numerous air vessels all along the supply pipe lines.

The deflection of nozzles from wheels, however, is wasteful of water, and the air vessels, while they may preserve the pipe-line from rupture, are probably the cause of the pulsations of pressure referred to.



A Non-Return Air Vessel for Hydraulic Power Conduits. Designed by E. S. Cobb, San Francisco, Cal.

Mr. E. S. Cobb, of the firm of Cobb & Hesselmeyer, engineers, of San Francisco, who, in some recent practice found this difficulty of water-ram to contend with, has prepared a method of dealing with it that may interest the readers of Engineering News.

Mr. Cobb proposes the employment of what may be called single-acting air vessels, which are illustrated in the accompanying cut. A is a common air vessel attached to the pipe line B, and provided with a valve C, opening freely inward, but closing by gravity as soon as there is an equilibrium of pressure between the pipe and the air vessel, thus preventing any return flow or resilient action of the compressed air in the vessel A.

Above the valve C is a discharge or waste pipe D, provided with a loaded valve E, that opens by the water pressure at some predetermined point and permits the escape of enough water to restore an equilibrium and permit the valve C to again open with a change of pressure.

A COMBINED SURFACE CONDENSER AND WATER COOLER.

We illustrate herewith a new apparatus designed and patented by Mr. Edward F. White, M. Am. Soc. M. E., 116 Liberty St., New York, in which the functions of a surface condenser are combined with the cooling of the water used for condensing purposes. The increasing tendency to use compound condensing engines in locations where there is not an ample supply of condensing water is creating a demand for some means of cooling the water so that it may be used over and over again. Many years ago great ponds were used for this purpose, but it is evident that they are impracticable in most locations. More recently cooling towers have been erected in which the heated water is allowed to trickle down over fagots of brush or an open-built structure of thin planks, while air is passed through the tower, evaporating part of the water and cooling the remainder. In the latest inventions in this line an air blast of great volume and low pressure, produced by a fan, is blown through the tower in order to bring the air and water into contact rapidly and by this means to diminish the size and cost of the tower. In recent forms of cooling towers their interior is stacked with terra cotta pipes, sheets of iron or wire network, over which the water trickles, thus exposing a large surface to the air. In Mr. White's cooling apparatus the water is spread in thin films over the inner surface of a great number of light galvanized iron

leader pipes, placed one within the other, leaving annular space about ¾-in. wide, through which the air for cooling the water and evaporating a portion of it is caused to pass by means of an exhaust fan. The cooler and condenser are thus combined in one structure.

Referring to the accompanying drawings, A is a vertical cast or wrought-iron cylinder extending between the top and bottom tube heads B and C. In the interior of the cylinder A are contained the condenser tubes D, which are of thin brass. The surrounding space about these tubes and within the cylinder A is the condensing steam space, into which the engine exhaust pipe R enters at the top. These brass tubes screw or are expanded into the lower head C and are fitted into the head B with specially designed expansion rings T. E is a water chamber between the heads C and F, into which the circulating water is received through the pipe G from the circulating pump. Within the several brass tubes D are wrought-iron pipes H, which screw into the lower head F of the water chamber; the annular spaces W, Fig. 2, between these iron pipes H and the brass tubes D form the passages for the circulating water. These spaces are divided by means of spiral windings I (see Fig. 2) secured to the inside of the iron pipes before placing into position, so that the course of the circulating water is spiral about the iron tubes in the above described annular spaces. At the top end of the iron pipes H a special head V, Fig. 2, is fitted which directs the flowing (heated) circulating water in proper proportion against the inside surfaces of the light galvanized leader pipes J, Fig. 2, along which surfaces this water descends, finally issuing at the lower end and falling into the cistern below. K is a cast-iron foundation bed which rests upon the walls of a water-storage cistern L. M is an ordinary housed exhauster or ventilating fan connected by means of the hood N with the top of the condenser. The action of this fan is to exhaust the air of the surrounding room through the openings O O at the bottom of the apparatus and up through the annular spaces between the cooling tubes J within the iron pipes H, discharging the same (now heated and saturated with moisture) into the ventilating flue or shaft; the action of this air circulation and simultaneous vapor absorption is to cool the circulating water.

A test of one of the elementary tube systems of the apparatus, made by Prof. D. S. Jacobus at the Stevens Institute of Technology, Hoboken, N. J., gave some data from which the capacity of an apparatus of a given extent of surface may be calculated. In these tests the condenser surface, or surface of the brass tube that condenses the steam, was 15.76 sq. ft., and the water-cooling surface, or surface of the concentric sheet-iron tubes used for cooling the circulating water, was 44 sq. ft., except in the first test, when it was only 34.5 sq. ft.

Results of Tests of E. F. White's Self-Cooling Condenser.

	Date of test. Sept. 24.	Oct. 7.	Oct. 8.	Oct. 10.
Av. temp. air surrndg condenser, °F.	66	59.3	53	51
Humidity of air around condenser, %	54	57	53	59
Temp. of circulating water, initial	100	121	122	131
" " " " final	..	145	..	157
Wt. of circ. water evaporated and mingled with air, lbs. per hr.	..	172	131.2	163.6
Wt. of steam condensed, lbs. per hr.	112.8	216.0	158.2	198.0
Temp. cond. steam leavg condnsr, °F.	99.6	148.5	133.6	153.4
Vacuum, in inches of mercury	24.3	20.5	23.0	20.5
Temperature of fan exhaust, deg. F.	108	118	110	123
Lbs. of water circulated per lb. of steam condensed	78.4	39.2	63.6	42.0
Steam condensed in lbs. per sq. ft. of condensing surface, per hour	7.16	13.7	10.1	12.6
Sq. ft. of condensing surface required per HP., if engine consumed 16 lbs. steam per hr. per HP.	2.3	1.2	1.6	1.3

A location in which a self-cooling condenser of the type designed should prove especially valuable is the basement steam plant of tall office buildings. In such steam plants it is customary to employ an exhaust fan for ventilating and reducing the heat in the engine and boiler room, discharging the heated air through a flue to the roof. By placing a condenser in the path of the hot air as it passes to the exhaust fan there is secured, in addition to the ventilation of the room, the cooling of the condensing water and the applying of distilled water from the surface condenser for feeding the boilers. The fact that in such a case the air supplied to the condenser is warm air is no disadvantage, since warm air has a greater capacity than cold air for absorbing water and so cooling the circulating water by evaporation.

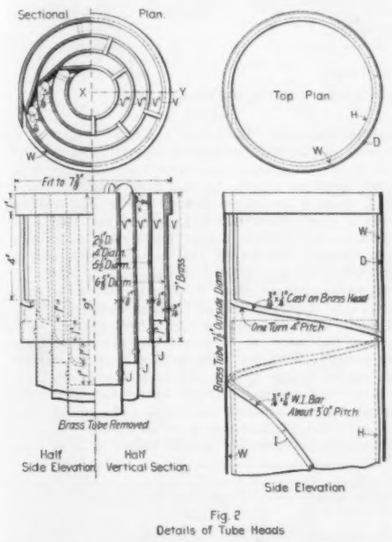


Fig. 2.—Details of Tube Heads of White's Self-Cooling Condenser.

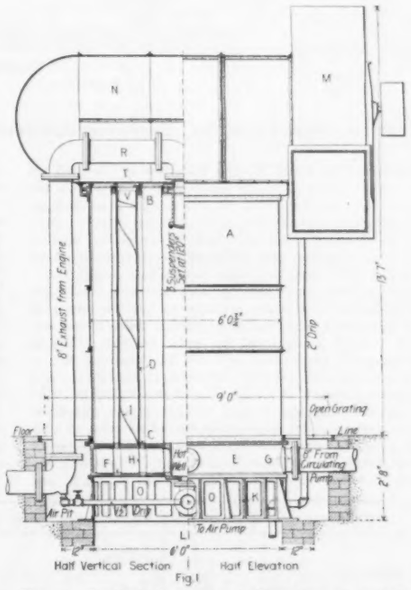


Fig. 1.—Vertical Section and Elevation of Self-Cooling Surface Condenser.

Designed by E. F. White, 136 Liberty St., New York City.

TESTS OF AN IMPULSE WATER WHEEL.

Two water-wheels of the "tangential" or "impulse" type, known as the "Cascade" wheel, made by The James Leffel Co., Springfield, O., were recently tested in the mechanical engineering laboratory of the Ohio State University, and the results are reported in the May number of the "Journal of the Franklin Institute." The type of wheel is similar to that commonly known as the "Pelton" wheel, and also to the Cazin wheel, which was described in our issue of May 27, 1897. It is adapted, like the others of its class, for use where small quantities of water under very high heads are available.

The Cascade wheel has two separate sets of buckets, located alternately on each side of the central, continuous, dividing ridge, projecting a little in front of the entering edge of the buckets. This dividing ridge has a sharp cutting edge, which serves to divide the jet of water before it touches or reaches the buckets into two equal portions, so that each portion of this single jet is received separately on each side of the dividing ridge. One-half of the jet is therefore received by one series of buckets independently of the other half, which is received by the other series. Each series of buckets on each side of this continuous dividing edge is so arranged that no two come opposite each other, and, as a consequence, the buckets of each series catch the water alternately.

The claim is made for this alternating arrangement of buckets that it secures greater steadiness of motion, since it is equivalent to twice the number of buckets, and the impulses are therefore divided more regularly on the wheel.

The two wheels tested were respectively 28 ins. and 30 ins. in diameter. Six tests were made on each wheel, and the principal results are the following:

	Head, ft.	Flow of water, lbs. per min.	Revs. per min.	Brakeload, lbs.	HP. developed.	Efficiency, per cent.	Velocity of wheel, ft. pr sec.
38-in. wheel...	165.3	3,330	309.8	80	13.662	90.04	47.75
	164.3	3,318	331.2	75	15.064	91.02	50.83
	165.7	3,335	273.6	90	14.924	89.16	41.66
	147.7	3,135	337.0	60	12.254	87.34	52.08
	155.3	3,222	336.0	65	13.236	87.30	52.02
	157.0	3,238	316.2	70	13.414	87.06	48.75
26-in. wheel...	160.0	2,075	482.8	30	8.778	87.23	49.80
	163.4	2,085	447.0	35	9.482	91.85	46.20
	164.5	2,078	377.4	40	9.149	89.40	37.95
	164.8	3,324	491.8	50	14.903	87.76	50.90
	166.2	3,340	445.2	55	14.840	88.20	46.25
	163.2	3,309	400.0	60	14.545	88.88	41.50

EXPERIMENTS IN BOILER BRACING.*

By Francis J. Cole, M. Am. Soc. M. E.†

The following investigation into the holding power, at different temperatures, of various styles of locomotive firebox crown stays, was made by the writer, for a prominent railroad company. The results are thought to be of sufficient interest to present to this Society.

The object in view was to test them as nearly as possible under the same conditions as in actual service, when used in staying the firebox of a locomotive, and particularly to note the relative decrease of the holding power at high temperatures.

In all these tests, it is assumed that the bolts are spaced 4 × 4 ins. c. to c., supporting an area of 16 sq. ins.

The total stress which each one would be required to sustain, due to the pressure of the steam, would be this area multiplied by the maximum boiler pressure.

The pocketing or bagging down, which is characteristic of an overheated crown sheet caused by low water, was imitated by using a bearing plate of ½-in. steel, 8 × 8 ins. square, with a hole 4½ ins. in diameter bored through its centre. The area of this hole is 15.9 sq. ins. The specimens were screwed or driven into pieces of ⅝-in. steel plate, 12 × 12 ins. square.

A 100,000-lb. Riehle screw testing machine was used, the specimen plate and bolt being inverted, with the bearing plate between it and the head of the machine, the staybolt hanging down through the middle. Sixteen different styles of crown stays were made, specimens numbered 1 to 16—6 test pieces, each of 1 to 4; and 4 pieces, each 5 to 16, numbered 1 to 76.

These specimens represent the ordinary forms most commonly in use, and other styles which suggest themselves. The material used was 1-in. round mild steel of 58,390 lbs. ultimate tensile strength, with an elastic limit of 38,900 lbs., and an elongation of 30.25% in 8 ins. The only exceptions to this were tests No. 2, specimen 6; and No. 70, specimen 16, which after fracture showed unmistakably to have been made of iron.

The ⅝-in. steel sheets, 12 × 12 ins. (a few of the first were 6 × 6 ins.) square, into which the bolts were screwed, were mostly cut from one large sheet, having lengthwise an ultimate tensile strength of 59,150 lbs., elastic limit of 28,800 lbs., with an elongation of 31.75% in 4 ins., and crosswise an ultimate tensile strength of 58,400 lbs., elastic limit of 28,040 lbs., with an elongation of 28% in 4 ins., both ways showing a silky fracture.

The specimens were heated in a small portable forge, alongside the testing machine. The plates, with the bolts projecting upward, were placed on the fire, and the heat localized in the center over a diameter of about 6 ins., by keeping a small, bright fire and dampening the outside with fine wet coal, to keep it from spreading.

In this method of heating, the head, or nut, would be

*A paper presented at the Hartford meeting of the American Society of Mechanical Engineers.

†Chief Draftsman Rogers Locomotive Works, Paterson, N. J.

hotter than the rest of the sheet, imitating in a measure the conditions which are present in a locomotive firebox. In all the hot tests the sheets were heated to a bright red, but in the first tests, Nos. 1—22, owing to the slow speed of the machine, and the time consumed in centering the specimen, the fracture did not take place until some of them were almost black; in the tests after No. 22, the speed was very much quicker, and arrangements were made for centering the specimens very rapidly. Evidently the temperature at parting is the correct one upon which to base the holding power of the bolts.

The average of the tests, in which those of lower temperature and doubtful results are not considered, is as follows:

Spec. No.	Tensile strength, cold.	Strength, hot.	Remarks.
	lbs.	lbs.	
1	16,350	3,470	Head ⅛-in. above sheet, riveted just enough to make steam tight; head not to exceed 1¼ ins. diameter.
2	16,700	3,473	Head ⅛-in. above sheet, riveted over.
3	17,600	4,040	Head 3-16-in. above sheet, riveted over.
4	20,733	4,000	Head ¼-in. above sheet, riveted over.
5	41,950	.....	⅞-in. std. nut tapped out to 1 in., 12 threads and riveted over; project about 1-16-in. to ¼-in.
6	42,000	6,000	1-in. std. nut, 12 threads, riveted over; projects about 1-16-in. to ⅛-in.
7	38,120	7,095	Button head, ⅞-in. groove.
8	39,800	6,933	Button head, 13-16-in. groove.
9	.....	7,500	Button head, ¾-in. groove.
10	39,800	7,483	Button head, 15-16-in. groove.
11	39,800	8,766	Button head, no groove, countersunk.
12	42,580	9,333	Button head, no groove, 3-16-in. copper washer.
13	43,100	10,150	Button head, with 1 1-16-in. reamed hole.
14	39,720	7,816	1-in std. nut, 12 threads, nut countersunk ¼-in. and well riveted over.
15	24,000	4,613	Screwed in sheet, 12 threads, rivet head ⅝-in. high and ½-in. diameter; largest head which can be formed.
16	40,300	9,730	Button head, with 1¼-in. tapered rmd hole, 3-in. thimble and nut.

Regarding the holding power of stay bolts screwed through ⅝-in. plate and riveted over, as shown in specimens 1 to 4 and 15, it will be observed that the average holding power when cold is 16,350 lbs. for the worst, and 24,000 lbs. for the best; and when hot, 3,470 lbs. for the worst, and 4,613 lbs. for the best. This would indicate that the best riveted head which can be formed cold, made in the usual conical shape, has a holding power, hot and cold, very much less than the worst form of bolt with solid head, even when nicked or grooved deeply under the head, or bolt screwed through with a nut on under side of sheet.

It does not appear that the solid button head bolts are deficient in holding power when tested in this manner, but the principal objection to their use is the liability of injury when screwed into a firebox where the holes are not tapped at right angles to the sheet, and where the surface of the sheet is curved. This objection can easily be removed by properly seating the head. It is the regular practice of the locomotive company with which the writer is connected, to use a seating tool, which faces off the underside of the sheet exactly at right angles to the longitudinal axis of the bolt. This not only insures a much tighter fit, but guarantees absolutely against any bending of the head, when screwing it close up to the crown sheet.

The holding power of the stay bolt when provided with a nut is considerably increased when red hot, by countersinking the nut and well riveting the bolt into the same, as shown in specimen No. 14.

The characteristic failure of the bolts when screwed through and riveted over, was by the sheet bagging down, stretching out the threads to a bell-mouth shape, and shearing off a small annular ring representing the thickness of the riveting. It will be observed, when referring to specimens 1 to 4 and 15, that the edges of the head are very shallow where they are sheared off in line with the edge of hole, and that the holes are stretched to such an extent that the threads lost their holding power. Generally speaking, the use of a nut increases the holding power of the stay bolt over the plain riveting, when tested cold, about 100%, and 50% when heated to a bright red.

One of the most noticeable features shown in these tests is the comparatively slight decrease in holding power of any of the forms of crown stays until a temperature exceeding a black or dull red has been reached. This is especially so in the case of test No. 14, specimen No. 1, which, at a dull red, showed a strength of 14,800 lbs., and the average strength of the same, cold, was 16,350 lbs. The results of the tests would seem to support the statement that the average holding power of the usual form of stay bolt at a dull red or almost black heat would be decreased from its strength cold about 50%, and at a bright red, decreased to about one-fifth of its original strength, except in specimens 11, 12, 13, and 16, which are decreased to about one-fourth of their original strength. In the case of specimens 13 and 16, their holding power would be very much increased by the use of a thicker crown sheet, as they mostly failed, both hot and cold, by the head pulling through the sheet.

The conclusions of the writer are:

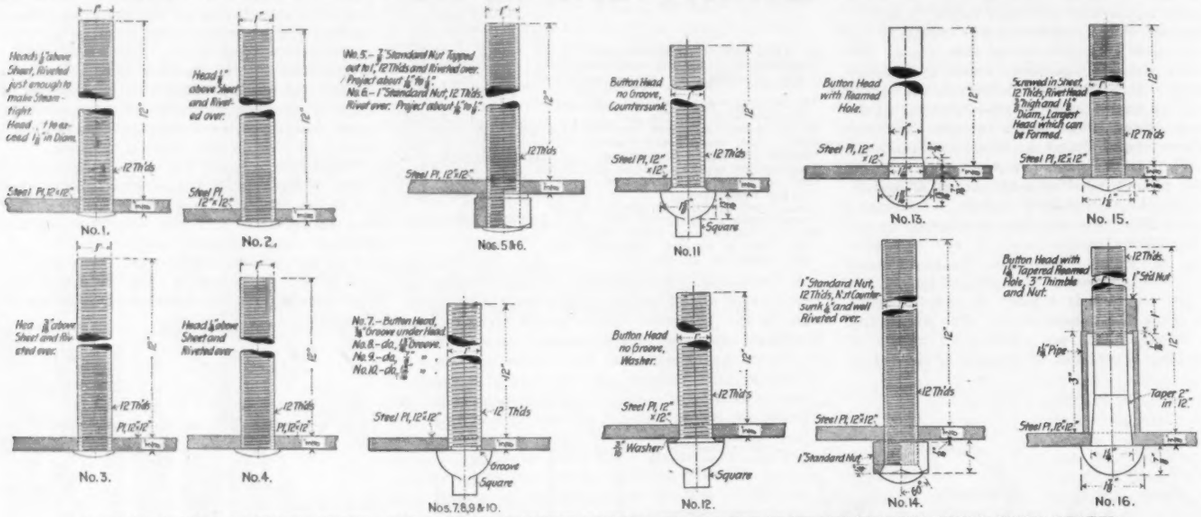
(a) That the center rows (5 to 10, according to the size of boiler) of the crown stays should be provided with solid button heads like No. 11, or with nuts like No. 14, to prevent pulling through in case the crown sheet is overheated.

(b) Grooving or cutting out the first thread under the head should be avoided. It not only weakens the bolt in its most vital point, but the possibility exists that some bolts are liable to be cut deeper than necessary by careless workmen. Moreover, it is unnecessary, as tighter work can be done by slightly countersinking the sheet.

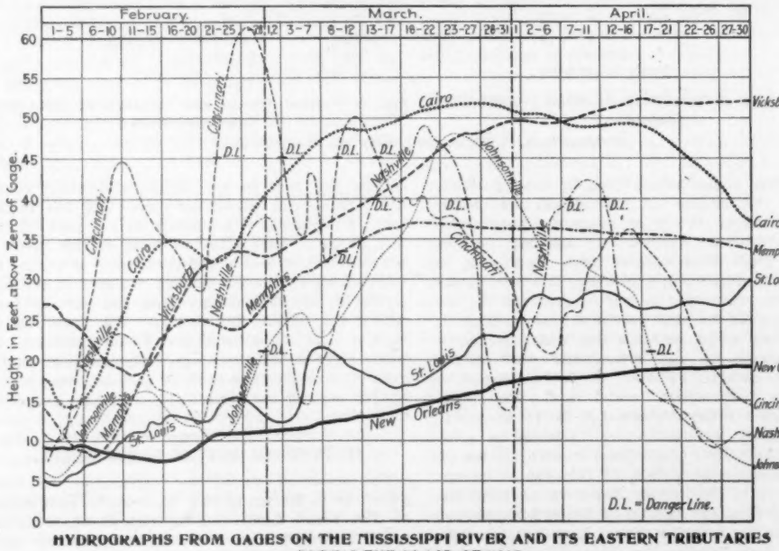
(c) It is good practice to enlarge the end screwed in the crown sheet for 1 in. or 1¼ ins. directly under the button head, making it slightly taper. For 1-in. round crown stays a good proportion is to upset the lower end for 1 5-32-in. or 1 3-16-in. thread, leaving the upper end for 1-in. thread. For 1⅛-in. round stays, lower end 1 9-32 ins., or 1 5-16 ins. upper end, for 1⅛-in. thread.

(d) The argument often advanced, that it is safer in radial stay boilers to omit all heads or nuts on firebox ends of crown stays and allow a few to pull through easily in case of low water so as to put out the fire and relieve the pressure, does not seem to hold good in practice, as the sudden letting go of a few bolts throws such an additional load on the adjacent ones, that they are frequently unable to stand the strain and tear out row by row until the whole crown is blown down.

(e) As crown sheets are usually higher in front than behind and arched in the center in radial stay boilers, good practice indicates that a few crown stays (say 10 or 12) in the front and in the center—the highest point—should be left without heads or nuts, and simply riveted over. In case of low water these would pull out and relieve the pressure, before the rest gave way. A prominent railroad having this in view, leaves every other crown stay riveted over without solid button head or nut.



VARIOUS STYLES OF CROWN SHEET STAYS FOR LOCOMOTIVE BOILERS, TESTED FOR ULTIMATE HOLDING POWER WHEN HEATED.



HYDROGRAPHS FROM GAGES ON THE MISSISSIPPI RIVER AND ITS EASTERN TRIBUTARIES DURING THE FLOOD OF 1897.

(Nashville is on the Cumberland River and Johnsonville is on the Tennessee River.)

(f) It is better to face the sheet with a cutter, allowing the solid finished metal surfaces to come together without twisting or bending the crown stay, than to use a copper washer or to bend the bolt under the head in attempting to tighten it up against a rough uneven surface.

HYDROGRAPHS OF THE MISSISSIPPI FLOOD OF 1897.

As a matter of interest in connection with the paper of Mr. Starling on the Mississippi Flood of 1897, published in our last week's issue, we present herewith hydrographs from the gages at principal points along the lower Mississippi during the present season's flood, and also the record of the gages at Cincinnati, on the Ohio, Nashville, on the Cumberland, and Johnsonville, on the Tennessee River. It will be remembered that both these rivers empty into the Ohio some 30 miles above Cairo, and that the gaging points above-named are a hundred miles or so above the mouths of the streams. The effect of the variations of these streams and of the upper Ohio on the Cairo gage is made evident by the diagram. We may add that we have redrawn these hydrographs from a chart in the "Monthly Weather Review," the official publication of the Government Weather Bureau, and they may be relied on as correct.

Results of Tests of Crown Stay Bolts for Locomotive Boilers.

Specimen No.	Test No.	Elastic Limit.	Tensile Strength.	Time Seconds.	Remarks.
		Lbs.	Lbs.		
1	4	11,600	16,500		Cold 6" plate; pulled through sheet.
1	10	13,000	19,400		Cold.
1	14	11,000	14,900		Dull red; scarcely perceptible; almost black after parting.
1	57		3,500	13	Cherry red; not quite as hot as No. 56; pulled through sheet.
1	58		3,440	11	Bright red after parting; pulled through sheet.
1	66	10,500	16,200		6" plate; cold; pulled through sheet.
2	6	12,400	16,700		Cold 6" plate.
2	18		6,300		Red.
2	19		6,300		Red.
2	41		3,450	13	Bright red; 6" plate.
2	55		3,400	10	Bright red; pulled through sheet.
2	56		3,570	10	Bright red after parting; pulled through sheet.
3	3	12,000	17,600		Cold 6" plate.
3	17		9,300		Dull red after parting.
3	39		5,700		Cherry red.
3	40		3,850	12	6" plate; very bright red.
3	53		4,300	12	Bright red; pulled through sheet.
3	54		3,970	13	Bright red after parting pulled through sheet.
4	5	13,300	19,100		Cold 6" plate.
4	8	16,000	23,300		Almost black after parting.
4	12	6,800	9,900		6" plate; cold.
4	22	14,000	20,800		Cherry red, not quite as hot as No. 58; pulled through sheet.
4	59		4,300	16	
4	60		3,900	17	Bright red after parting; pulled through sheet.
5	7	28,000	43,100		Cold 6" plate.
5	11	14,500	21,500		Dull red; almost black after parting.
5	15	13,900	23,300		Dull red; almost black after parting.
5	21		40,900		Cold 6" plate.
6	1	38,500	42,000		Cold 6" plate.
6	2	34,000	32,200		Cold 6" plate iron.
6	13	12,000	17,400		Dull red after parting.
6	16		6,000		Plate red; nut bright red.
7	25	23,000	39,340		Cold, broke in nick.
7	29		7,950	15	Bright red; parted while bright red, same as No. 28.
7	28		6,340	16	Bright red; broke in nick.
7	47	22,000	37,000		Cold; parted in nick.
8	32		7,700	10	Bright red; broke in nick.
8	33		6,400	12	Bright red; broke in nick.
8	34		6 700	16	Bright red; parted in nick.
8	52	26,000	39,800		Cold; parted midway, 6" from lower end.
9	42		6,630	23	Bright red; parted in nick.
9	43		7,300	23	Bright red; parted at first thread.
9	44		7,770	20	Bright red; parted in nick.
9	45		8,100	24	Bright red; parted in nick.
10	48		7,700	25	Bright red; parted in first thread.
10	49		7,500	18	Bright red; parted in first thread.
10	50	26,800	39,800		Cold; parted in centre 7½" down.
10	51		7,250	22	Bright red; parted in first thread.
11	24	27,000	39,800		Cold; broke in bolt midway.
11	26		8,000	20	Bright red; parted while bright red; if anything a little hotter than No. 27.
11	36		9,400	18	Bright red; broke in first thread below nick.
11	39		8,900	21	Bright red.
12	30		10,000	18	Bright red; parted while bright red.
12	31		9,200	19	Bright red; parted while bright red.
12	37		8,800	19	Bright red; broke in first thread below nick.
13	48	28,300	42,580		Cold; parted 3" from lower end.
13	23	32,500	43,100		Cold; pulled head through sheet.
13	26	7,000 bright red.	26,000 black.		Slow speed; red, head bright red.
13	27		9,700	20	Bright red; faster speed than No. 26; parted while bright red.
13	35		10,600	24	Bright red; pulled through sheet.
14	67	19,000	30,730		Pulled cold; bolt broke.
14	71		7,540	18	Bright red after parting.
14	72		7,980	28	Bright red; red after parting, stripped in nut.
14	73		8,000	23	Bright red after parting; bolt broke between nut and sheet; nut split slightly on one side, and riveting pulled in flush with top of nut.
15	61	17,600	24,000		Pulled cold; pulled through sheet, head sheared.
15	62		4,400	25	Bright red after parting; pulled through sheet.
15	64		4,900	22	Bright red; red after parting; pulled through sheet.
15	65		4,580	13	Bright red after parting; pulled through sheet.
16	63	28,800	40,300		Pulled cold; bolt broke, 7" from plate.
16	68		9,900	17	Bright red after parting; pulled through sheet.
16	69		9,800	29	Bright red after parting; pulled through sheet.
16	70		6,630	14	Bright red after parting; bolt broke; found to be iron.

Head ¼" above sheet, riveted just enough to make steam tight; head not to exceed 1¼" diameter.

Head ¼" above sheet, riveted over.

Head ⅛" above sheet, riveted over.

Head ½" above sheet, riveted over.

½" std. nut tapped out to 1" 13 threads and riveted over; project about ⅛" to ¼".

1" std. nut, 13 threads riveted over; project about ⅛" to ¼"

Button head, 1" groove.

Button head, 1" groove.

Button head, 1⅛" groove.

Button head, no groove, countersunk.

Button head, no groove, ⅛" copper washer.

Button head with 1⅛" reamed hole.

1" std. nut, 13 threads, nut countersunk ¼" and well riveted over.

Screwed in sheet, 13 threads, rivet head 1" high and 1½" diam., largest head which can be formed.

Button head with 1¼" inbored reamed hole, 3" thimble and nut.

THE WATER SUPPLY OF HIGH BUILDINGS.

We illustrate herewith an arrangement of apparatus designed by Mr. Reginald Pelham Bolton, C. E., Syndicate Building, Liberty and Nassau Sts., New York city, for supplying water at high pressures to the upper floors of high office buildings. Fig. 1 is a diagram representing two adjoining 15-story buildings, one protected by the old-style tank system, the tank on the roof being supplied by a pump in the basement, and the other by Mr. Bolton's system, in which the roof tank is dispensed with and three air-pressure tanks in the basement are substituted. The diagram shows that in the building protected by a tank on the roof only a small head of water is available for extinguishing fires on the upper floors. The regular city pressure reaches only to the fourth floor. The fire engine, out of doors, cannot be connected to the pipe supplying the tank so as to give any higher pressure on the upper floors than the tank itself does, since the pipe is open at its upper end.

In the system shown in the building on the right one or more pumps drawing water from the "surge tank" in the basement, which is filled by the city supply, discharge it into the three tanks or drums, the upper portions of which contain air under pressure. In very tall buildings a separate pump is used for each drum, and separate risers are used, leading from the drums, one to supply the roof and upper floors, one for the lower floors, and a third may be used for intermediate floors, different pressures being maintained in the several drums corresponding to the heights to which the water in each is to be raised. In case of fire all the tanks may be connected together by means of valves, and water supplied to them by a fire pump. In addition to this a pipe which connects with the riser leading to the roof is led to the sidewalk outside of the building and is there provided with standard unions of the fire department, so that water may be delivered into it by a steam fire engine. Fig. 2 shows Mr. Bolton's apparatus in somewhat greater detail than Fig. 1. It shows also how a hot-water system may also be provided. The air compressor is operated only when necessary to pump air into the tanks to make up for leakage.

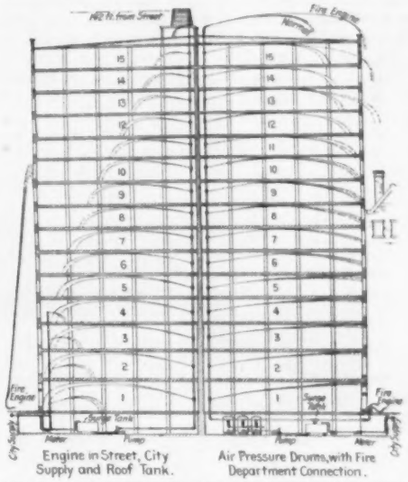


Fig. 1.—Comparative Fire Streams for the Protection of Tall Buildings.

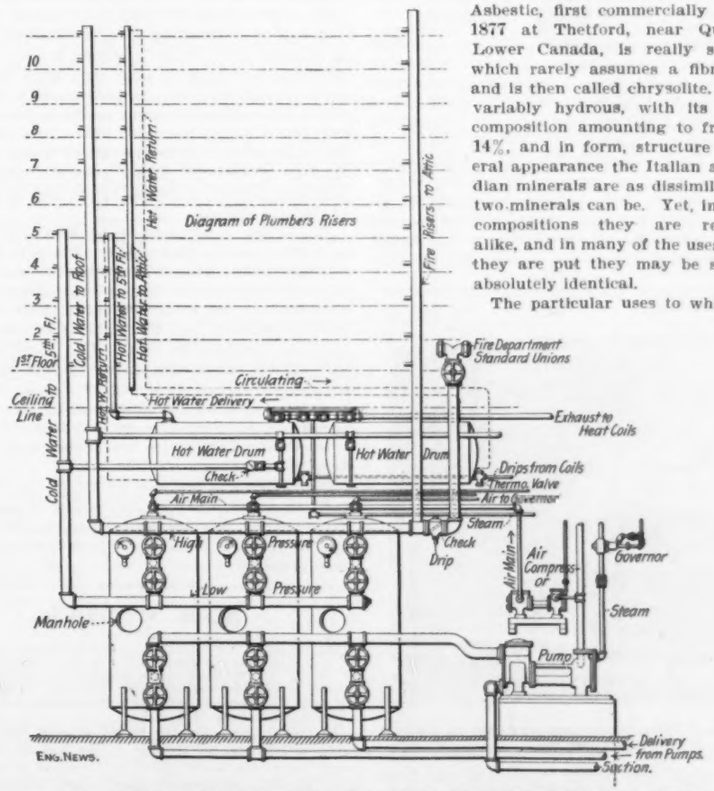


FIG. 2.—SYSTEM OF WATER SUPPLY AND FIRE PROTECTION FOR TALL BUILDINGS.
Designed by Mr. Reginald Pelham Bolton, C. E., Syndicate Building, New York City.

ASBESTOS AND ASBESTIC.

From a paper lately read by Mr. Robert H. Jones before the Society of Arts, of England, the following abstract is made of a description of a material largely used in the United States for fireproofing and other protective purposes:

Asbestos proper as now used is largely obtained from the Italian mines opened in Lombardy in 1866. The Italian asbestos is a variety of hornblende, or pyroxene; it is anhydrous. Asbestic, first commercially mined in 1877 at Thetford, near Quebec, in Lower Canada, is really serpentine, which rarely assumes a fibrous form and is then called chrysolite. It is invariably hydrous, with its water of composition amounting to from 13 to 14%, and in form, structure and general appearance the Italian and Canadian minerals are as dissimilar as any two minerals can be. Yet, in chemical compositions they are remarkably alike, and in many of the uses to which they are put they may be said to be absolutely identical.

The particular uses to which asbestic, as distinguished from asbestos, are put, are thus referred to by Mr. Jones:

The first idea which occurred to the discoverer of the Canadian mineral was to pulverize it and use it in this state as a cement or plaster. The first experiments were made by the H. W. Johns Mfg. Co., of New York, the well-known makers of asbestos roofing, pipe covering, paints, etc. It was found that in this state the asbestic made a most

excellent wall plaster, requiring neither hair nor sand in its manufacture, as the natural fibre supplied the one and the pulverized rock the other component. This plaster, composed exclusively of this material is both fireproof and a non-conductor of heat and sound; it is also odorless, vermin-proof and a natural filter. It is as elastic as fibrous asbestos, so that there is no danger of chipping, crumbling, fracture or displacement, and a nail can be as readily driven into it as into a board. It will adhere to metal or to glass, and walls so plastered are proof against settlement-cracks.

Asbestic is also applied to the manufacture of a special roofing material which is light and cool and proof against burning sparks and cinders and can be used in any climate.

FIG. 1.—DOUBLE TRACK, 246¼ FT. SPAN SWING BRIDGE ACROSS THE CALUMET RIVER, CHICAGO, ILL.
W. L. Stebbings, Chicago, Ill., Chief Engineer.

EQUALIZING GEAR FOR OPERATING MACHINERY OF A 246½-FT. SWING BRIDGE, CHICAGO, ILL.

A somewhat novel and withal effective departure in applying the power for the operation of a swing bridge has been employed on a 246½-ft. double track railway swing bridge recently built across the Calumet River, at Chicago, Ill. A general view of this swing span is shown by Fig. 1. It was built for the Chicago, Lake Shore & Eastern Ry., whose line runs through the "south works" of the Illinois Steel Co., and over whose tracks all deliveries to the works are made. At the point of crossing the Calumet River is 329 ft. wide, and the War Department requires a channel 200 ft. wide and 20 ft. deep. The bridge consists of two fixed approach spans, and the 246 ft. 6 ins. swing span, already noted, which leaves on each side of the centre pier a channel 100 ft. wide.

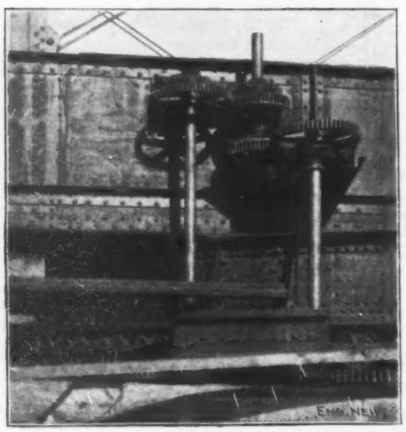


Fig. 2.—View of Pinion Shaft Equalizing Gear for Calumet River Swing Span.

In building the piers the open caisson method was used. These caissons rest on piles cut off 16 ft. below datum—an arbitrary zero point established by the Trustees of the Illinois & Michigan Canal as the low water mark of Lake Michigan in 1847—and are surmounted by the piers of first-class masonry laid in Alpha Portland cement mortar. For the masonry Joliet limestone was used up to an elevation of — 2 ft., and from this point to an elevation of + 3.5 ft. Vigo, Indiana, sandstone was used. The center pier is 39 ft. in diameter, with a coping 40 ft. in diameter. The foundation and masonry work was done by Morris & Walt, of Chicago, Ill., general contractors.

The superstructure was built by the Edge Moor Bridge Works, of Wilmington, Del. Soft steel was used throughout, except for the eye bars and pins, which are of medium steel. The swing span was proportioned as a continuous girder having four points of support, but incapable of transferring shear across the center panel, and the moving load consisted of 4,320 lbs. per lin. ft. of track hauled by two 100½-ton locomotives. The span consists of eight panels, 27 ft. 2¼ ins. long, and one center panel, 28 ft long. Two trusses are used spaced 29 ft. apart c. to c., and the track stringers are spaced 4 ft. each side of the center line of each track. The trusses are carried on a square framework of plate girders 29 ft. long each, which in turn is carried on eight girders radiating from a common center to a circular drum 36 ft. in diameter. By this construction a little more than one-eighth of the load upon each radial girder is transmitted to the center pivot, the remainder going to the drum. The live ring upon which the drum travels consists of 78 cast steel wheels, 14 ins. in diameter, and with a 7-in. face. The ends of the trusses are supported, when the bridge is closed, by wedges driven from the engine house.

The bridge is operated by an 8½ × 12-in. double, reversible engine, built by the Vulcan Iron Works, of Chicago, Ill., which also furnished the boiler and all machinery on the engine house floor. The engine operates the bridge swinging shaft through a geared equalizer, and these shafts in turn operate four pinions meshing with the circular rack, through two other equalizers attached to the circular drum girder, as shown by Fig. 2. The idea, it will be seen, was to distribute, by means of the equalizers, the stress, so as to reduce the liability of accident. This device has worked very successfully in operation.

The bridge was designed by Mr. W. L. Stebbings, Civil Engineer, Chicago, Ill., and was built under his direction. We are indebted to the designer for the information from which this description has been prepared.

BOOK REVIEWS.

THE RAILWAY BUILDER.—A hand-book for estimating the cost of American railway construction and equipment. By William Jasper Nicolls, M. Am. Soc. C. E. Fifth edition; revised and enlarged. Philadelphia: J. B. Lippincott Co. Flexible leather; 6½ × 4 ins.; pp. 283; illustrated. $2.

As the author intimates in his original preface, this work is intended for the use of the layman who seeks some knowledge of the methods of railway surveys, and the general practice in and cost of earthwork, masonry, permanent way and equipment. It is not an engineering hand-book; but it contains much of interest and value to those interested in engineering matters, and is useful to that extent. Mr. Nicolls, in this edition, brings up his work to the later practice, but in this confines himself somewhat too closely to what is done upon the Pennsylvania and on the Reading railways.

THE LOCOMOTIVE: ITS FAILURES AND REMEDIES.—By Thomas Pearce, Engineman, Great Western Ry. Published by the author, Wolverhampton, Eng. For sale in the United States by the D. Van Nostrand Co., New York city. Fourth edition. Cloth; 8vo.; pp. 96; also 16 double-page plates. $1.

This book is arranged in the form of questions and answers relative to the duties of enginemen, the operation of the valve gear and the making of repairs on the road. The title is somewhat misleading, since the greater part of the book is devoted to the consideration of the valves and valve gear. The 16 plates show eight positions of the cranks, pistons and valves with the right-hand crank leading, and eight with the left-hand crank leading. These diagrams are for an inside cylinder engine, with slide valves back to back between the cylinders. The description of the various positions is arranged in such long paragraphs that it is difficult to follow and understand it. The part referring to brakes and brake failures deals only with the automatic vacuum brake, as used on the Great Western Ry.

COOK'S TABLES OF YARDAGE CONSTANTS FOR RAILROAD AND LEVEE ESTIMATES.—Vest pocket edition. Being an abridgement of four complete earthwork tables for various slopes and widths of roadbed. Also formulas, slope and roadway adjustment tables, prismoidal corrections, etc., by which the true volume is readily obtained for any slope or width of roadway. By M. S. & F. W. Cook, Civil Engineers, Duluth, Minn. Published by the authors. 5 × 2⅝ ins.; 70 pp. $1.00.

The title describes the purpose of this little book. It is printed from photo-electrotype plates of manuscript tables and notes, and while sufficiently plain for use, letter press would have been less bulky and more easily read. The volume of earthwork is expressed only for each half-foot of either dimension of the cross-section; but closer results can be obtained by interpolation. The widths of roadways are given as 14, 18, 20 and 8 ft., the latter referring to levees; the tabular slopes are 1 on 1½, 1 on 1 and 1 on 3. These tables are intended for the convenience of railway engineers and contractors, and are especially adapted to preliminary field estimates. Fuller tables for office use are to be published hereafter.

DATA FOR HEATING AND VENTILATION. By Wm. J. Baldwin, M. Am. Soc. M. E. 12mo.; cloth; pp. 28. Price, 50 cts. Published by the author, 106 Beekman St., New York.

The object of this little book is to provide ready and approximate preliminary data for the architect or engineer who desires to find the first things necessary for the installation of a steam heating or ventilating apparatus. It is very brief, but excellent, as far as it goes, and the author promises to issue periodically additional concise data on the subject in small books of this form, and later to issue a bound volume of the completed series. We have condensed seven of his short empirical rules into the following:

Having given the cubic feet of air to pass through a building in an hour and warmed 100°F.

To obtain heat units, multiply by 2.
" " lbs. of steam required to warm divide by 500.
" " lbs. coal to be burned per hour divide by 5,000.
" " sq. ft. of grate area divide by 60,000.
" " " " " area of chimneys divide by 500,000.
" " horse power of the boiler divide by 15,000.
" " heating surface of the boiler divide by 1,000.

THE AERONAUTICAL ANNUAL, 1897. No. 3.—Devoted to the encouragement of experiments with aerial machines, and to the advancement of the science of Aerodynamics. Edited by James Means. W. B. Clarke & Co., Boston, Mass. 9 × 6 ins.; pp. 178; illustrated. $1.00.

The three issues of this annual contains about all that is known of the modern and scientific study of the problem of mechanical flight. The present number commences with a life sketch of Prof. Samuel P. Langley, Secretary of the Smithsonian Institution, and an article by Prof. Langley describing his trials, failures and comparative later success in the design and construction of "aerodromes," or machines sustained in the air by supporting surfaces and propelled by an engine operating screw propellers. The latest of these machines ascended nearly 100 ft. into the air, made an extreme flight of about three-quarters of a mile, and when the steam was exhausted and the propellers stopped, it settled gently and smoothly to the earth. Mr. Octave Chanute, Past President of the American Society of Civil Engineers, contributes two lengthy articles to the annual. The first takes up the question of "gliding flight," and details the results of numerous tests of machines designed for this special purpose; the second article discusses "sailing flight," and takes up the numerous theories advanced to account for the paradoxical effects noted. A biographical sketch of the late Otto Lilienthal is followed by the translation of several interesting articles by this unfortunate experimenter in man-flight. Mr. A. M. Herring, who assisted Mr. Chanute in his experiments, tells of the recent advances towards a solution of the problem of mechanical flight; Mr. E. C. Huffaker writes concerning the flight of the eagle, and Mr. Hiram S. Maxim warns engineers and experimenters that in designing screw propellers to work in air, the rules deduced from experiments on water will not so well apply to the aerial propeller. The conditions are very unlike, and his tests in air currents produced some curious and unexpected results.

VOCABULAIRE TECHNIQUE DES CHEMINS DE FER.—Termes Francais, Anglais et Americains. Par Lucien Serraillier, Avec 22 tableaux.

RAILWAY TECHNICAL VOCABULARY.—French, English and American Terms. By Lucien Serraillier. With 22 tables. Whittaker & Co., London and New York. 7½ × 5 ins.; 222 pp. $3. American pub.: The MacMillan Co., New York.

Instead of the ordinary alphabetical arrangement the author has grouped his terms according to the subject matter; and he does this because in this way alone can the

constituent parts of any appliance be placed under the appliance itself, and synonymous terms be bracketed together. This arrangement requires a little more work in finding the term sought, but it has compensating advantages, especially as the bulk of the book is reduced one-half by dispensing with one of the two sections of a bi-lingual dictionary. There are five general groups, with a special classification under each. These are—Administration, Traffic, Way and Works, Locomotives and Rolling Stock and General. The English synonyms for French words largely predominate over the special American terms, which latter are denoted by asterisks. But, taken altogether, the work is an exceedingly useful one. The translator of French technical literature is continually meeting with expressions either not found in the French dictionary, or given there with a different and non-technical meaning. In this work these expressions will be found applied to railway track, surveying, foundations, bridge work, masonry and brickwork, timber construction, etc. All parts of the locomotive and cars are given, and signalling plant and its operation, details of administration and traffic, and all manner of tools and machines are included. The translation of the terms used in metallurgy, in mechanics, in chemistry, in specifications, and in the drafting room are exceedingly useful. A series of metric conversion tables properly follow the general text, and these have a range not usually met with in metric tabular matter. Gradients are noted in millimeters per meter and the equivalent feet per mile; Fahrenheit degrees are compared with Centigrade, and pounds sterling per ton with franks per 100 kilograms, in addition to an extended comparison of the more commonly used weights, measures, areas and pressures.

THE MANUAL OF AMERICAN WATER-WORKS, 1897.—Compiled from Special Returns. Containing the History and Descriptions of the Source and Mode of Supply, Pumps, Reservoirs, Stand-Pipes, Distribution Systems, Pressures, Consumption, Revenue and Expenses, Cost, Debt, Sinking Fund, etc., etc., of the Water-Works of the United States and Canada, with Summaries for each State and Group of States, and Water Rates Charged in Over 1,250 Cities and Towns. Edited by M. N. Baker, Associate Editor of Engineering News. New York: The Engineering News Publishing Company. Cloth; 6½ × 9½ ins.; pp. 700; tables. Price, $3.00.

In accordance with a precedent established some time ago in reviewing our own publications, we confine ourselves principally to quoting the preface to the "Manual," as giving, in connection with the above matter from the title page, a good general idea of the contents of the volume.

This volume contains descriptions of all water-works completed, under construction or projected in the United States and Canada, up to the close of 1896, with later information concerning some new works and projects. The aim has been to give a brief but comprehensive description of each plant, including its history, general character, the capacity of the pumps, reservoirs, stand-pipes or filters; the extent of the distribution system; and the most important figures relating to the finances of each system. Great pains has been taken to collect information, in addition, bearing on the questions of the day, both relating to economics and to water-works practice, such as: The conditions of franchises; legal difficulties between private water-works companies and cities; conditions governing the use of meters; methods employed in raising money to meet the expenses of extensions to distribution systems; who pays, and how much, for tapping mains for service connections and who for the connections themselves; and whether the several towns listed have sewerage systems.

In general, the figures under distribution and financial, in the case of works built prior to 1896, are for the fiscal year 1895, or 1895-96, many years ending well into 1896. The date the last fiscal year closed is always stated, when ascertained, as well as the date of the report made for this volume and the name of the person who made the same.

The large number of works now requiring description renders necessary the greatest brevity consistent with reasonable fulness and perfect clearness, in order to keep the book within reasonable bounds. Notwithstanding the efforts made to compress the information, 611 closely printed pages are required for the body of this volume, besides which the introduction and the table of water-works take up some 30 pages more.

For convenience, the projected works are placed in their proper alphebetical order among the descriptions of completed plants, thus making one complete list of towns for each State and rendering it more easy to find the water-works status of any town. The various classes of works are distinguished by a simple system of numbering, explained in detail at the head of each group.

The table of water rates included in the "Manual" for 1889-90 proved to be of so much interest and value to water-works officials and others that it has again been made a special feature of the Manual, the fixture and meter rates charged in over 1,250 cities and towns having been collected and tabulated for this book.

Perhaps we may add that the "Manual" describes 3,341 complete water-works plants; and in addition 210 plants furnishing only a domestic supply, 120 furnishing only fire protection, and 154 that could not be classified, thus making about 3,800 works in all. Some of these works supply a number of towns, and, on the other hand, a number of cities have two or more plants, the net gain in number of towns supplied being 300. There are another 300 projected works described, so that altogether the book gives the water-supply status of 4,400 cities and towns in the United States and Canada, some 1,500 of which were not included in the last "Manual," which brought the record down to about July, 1891.

It may also be stated that the officials of each water-works plant are given and that it is stated for each city whether or not it has a sewerage system, and, if so, whether of the combined or separate type.

BLOCK SIGNAL OPERATION.—A Practical Manual. By Wm. L. Derr (Superintendent, Delaware Division, Erie Ry.). New York: D. Van Nostrand Co. Cloth; oblong; 7 × 4¾ ins.; pp. 270; illustrated. $1.50.

In view of the rapid introduction of the block system on American railways it is quite time that there should be a practical and up-to-date manual available for officers and railway employees. While the block system is already in use for controlling the regular traffic on many main lines, it is also very extensively adopted for the protection of such special points as busy junctions, grade crossings, etc., and both these divisions of the subject are treated of in this book. There is no discussion of the relative merits of the different systems of block working and no detailed description of the apparatus, the author's aim having been to present the latest practice in block signal operation which obtains in this country and in Europe. As the English practice is the result of long experience and must largely form the basis of practice in this country, it is natural that considerable space should be given to English rules and methods. The author does, however, present an original method of single-track blocking which is designed to ensure the holding at the proper passing sidings of trains to be met by opposing trains. This is of special interest, as the American railway system comprises such a large mileage of single-track lines carrying heavy traffic.

The book commences with a brief explanation of the train-dispatching system, and a sketch of the history of the block system (which dates from 1839, on the Great Western Ry., of England), including its introduction into this country. The general principles of block working are given, with the definitions of signals adopted by the American Railway Association. The laying out of block stations and the questions of signal bells, lamps, semaphores, towers, etc., are discussed. One entire chapter is devoted to the subject of blocking at crossings and junctions, and this is illustrated by a number of diagrams showing the arrangements of signals, derails, etc., for different arrangements of intersecting and connecting tracks. Manual blocking, or the system in which each signalman controls the signals at his station, is the subject of another chapter, in which are given the full regulations of the London & Northwestern Ry. and the Erie Ry. The Mozier system, with three-position semaphore, is mentioned, and also the method of operating outlying switches, while this chapter also includes the author's method of single-track blocking above referred to.

The author then describes the controlled-manual system and auto-manual system, in which each signalman has his signals controlled by the next signalman in advance or by an automatic device operated by the train. With this are given the rules of the New York Central R. R. for controlled-manual working on its four-track line, with examples of the caution and clearance cards issued to enginemen to authorize them to proceed against the signals. In the chapter on blocking by automatic signals there are given the rules of the Pennsylvania R. R. for the Union electro-pneumatic system, and the rules of the Lake Shore & Michigan Southern Ry. for the Hall system. One of the most interesting chapters is that on machine blocking for single-track lines, for Mr. Derr is well known as an advocate of the train-staff or train-tablet system. The general discussion on this subject is followed by the regulations of the London & Northwestern Ry. governing this method of operation, and a description of the system of working by pilotmen in case of any derangement of the machine blocking. The train-staff system has been adopted by the Chicago, Milwaukee & St. Paul Ry. for operating heavy traffic over a single-track link three miles long, which includes a bridge over the Mississippi River (Eng. News, April 11, 1895), and the regulations of this road are given in full. An appendix deals with the use of block signals for the protection of maintenance-of-way operations.

The book is well printed, in large type, on good paper, has an index, and the illustrations are clear and distinct, but it would have been better if a consecutive numbering of the cuts had been adopted. We must also make an unfavorable comment as to the oblong shape of the book, for which there is no reason, while it makes the book awkward to handle and especially awkward to file. There is no title on the back. These objections, however, refer to matters of form, and the book itself is a thoroughly good one, which will be extremely valuable to men in the engineering and operating departments of railway service.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The place selected for holding the annual convention of 1897 was Quebec, Canada, and at 9 a. m., on June 28, a party of about 130 members and guests left New York city by the New York Central R. R. for Quebec, by way of Montreal. The special train was made up of six cars, a baggage and smoking car, four day cars and a dining car. It had been arranged that vestibuled cars should be provided, but instead the train was made up of old cars without vestibules or toilet saloons. As there is always a large amount of visiting between the cars this involved considerable discomfort and some danger, while the ladies found it very trying to get from car to car on the way to and from the dining car, and the absence of toilet facilities on a trip of such length was the cause of unnecessary discomfort. The attempt to satisfactorily cater for 130 persons in a dining car seating only 30 was not a success, and it would have been better if a longer stop had been made at Albany for a regular dinner. Delays occurred all along the route, and the train reached Montreal about 12:30 a. m., June 29, after a run of 15½ hours, or 2½ hours more than scheduled time. In fact the New York Central R. R. not only did not live up to its agreement, but did not live up to its reputation for comfort, speed or punctuality. In spite of all inconveniences and discomforts, however, it was a merry party, and the trip was much enjoyed, the mountain scenery along the Adirondack & St. Lawrence Ry. being specially noticeable. The party spent the night at the Windsor Hotel.

On June 29, after breakfast, the greater number of the party proceeded by electric cars and open carry-alls to the Lachine Rapids on the St. Lawrence River, to visit the power canal and power station of the Lachine Rapids Hydraulic & Land Co., which company will supply circuit for lighting, railway and power purposes in Montreal. The works were described and illustrated in detail in our issue of Feb. 18, 1897. The cables of the transmission line are carried by crossarms on steel posts of lattice construction. Others of the party visited the Engineering Building and the Physics Building of McGill University, while others drove up Mount Royal or went sight-seeing about the city. At 2 and 2:10 p. m. the party left Montreal for Quebec by two special trains, made up of comfortable sleeping and parlor cars, provided by the courtesy of the Canadian Pacific Ry. Co. During the ride of about five hours the members of the party were notified of the numbers of the rooms assigned to them at the Chateau Frontenac, Quebec, and had their baggage checks exchanged for hotel checks, so that on arrival they had merely to call for the keys of their rooms, while the baggage was delivered during the evening. It may be noted that by some specially agreeable arrangement the tedious ceremony of the inspection of baggage by the customs officers was entirely dispensed with.

June 30 turned out to be a thoroughly wet day, which somewhat upset the program, but rather improved it than otherwise, since it resulted in two consecutive sessions being held for the reading and discussion of papers, which is certainly more conducive to a fair treatment of the technical part of the convention than are business sessions separated by excursions and other pleasures.

The meetings were held in the handsome council chamber of the City Hall, by the courtesy of the Hon. S. Napoleon Parent, the Mayor of Quebec. The first meeting opened about 10:30 a. m., June 30, addresses of welcome being made by Sir Adolphe Chapleau, Lieutenant Governor of the Province of Quebec, and the Hon. Mr. Marchand, Premier; also by Alderman T. H. Norris, representing the mayor, who was absent. These addresses were acknowledged by Mr. Benjamin M. Harrod, the President of the Society. Mr. Harrod then delivered the annual presidential address, an abstract of which we published in our last issue. The papers on the program were then taken up, and were soon disposed of, since only three papers were to be presented, none of which called for any very active or general discussion, although two of them might have been expected to bring forth a varied display of opinions from engineers making steel and structural steel work a specialty. As is usually the case at these conventions the discussions on the papers presented were brief and of no special interest or importance. The first two papers were disposed of before luncheon, and the third was finished in the early part of the proceedings of the afternoon meeting.

The Relation of Tensile Strength to Composition in Structural Steel.

By A. C. Cunningham.

To find the approximate tensile strength of structural steel, to a base of 40,000 lbs., add 1,000 lbs. for every 0.01% of carbon, and 1,000 lbs. for every 0.01% of phosphorus, neglecting all other elements in normal steels. Radical variations between calculated and actual strength indicate mixed steels, segregation, incorrect analyses, or unusual treatment in manufacture.

It has long been known that steel of about 1% carbon (or 100 carbon, as it is generally called) possesses the greatest tensile strength and that as the carbon increases or decreases from this point there is a decrease of tensile strength. It has also been assumed that all other elements besides carbon, entering into the composition of steel gave more or less strengthening effect, and it is known in the case of manganese that radical changes take place in the nature of the steel as the percentage of this element reaches certain amounts. Years of experience have taught that carbon is the most desirable element for giving strength to steel; that definite results can be produced by varying its amount, and that the gain of strength due to its increase is accompanied with less loss of other desirable properties than is the case with any other hardener. All other elements occurring in carbon steels may be considered as impurities or antidotes.

The above rule is so simple that a few trials will permanently impress it on the memory. The operation may be made mentally with great rapidity, and, as far as tried, is equally applicable to all kinds and makes of steel.

Written discussions were presented from Mr. H. H. Campbell and Mr. J. A. L. Waddell, the latter drawing comparisons between the results of the investigations of Messrs. Cunningham, Campbell and Webster, and giving 75,000 lbs. as the highest tensile strength of interest to the structural engineer. Mr. Wm. Metcalf referred to the use

of high grade steel in locomotive and machine work, and did not see why it should not be applied to structural work. Some engineers are already using steel of 90,000 and even 100,000 lbs. tensile strength, and he has recently been asked for steel with a tensile strength of 125,000 lbs. and an elastic limit of 60,000 lbs. The work of such investigations as that recorded in the paper is admirable as far as it goes, but the formulas are based only upon chemical composition and do not take manipulation into account, so that they are not a safe working guide, since variations in manipulation in manufacture make great changes in the strength of the steel. Mr. H. B. Seaman said that the use of steel of very high tensile strength in structural work would not be safe until bridge works turn out work as excellent as that turned out by locomotive works. So far from the tendency being towards higher figures he considered that for structural work there is a tendency towards lower figures, or about 50,000 lbs. tensile strength.

Recent Tests of Bridge Members.

By J. E. Greiner.

During the past two years the author has made a number of tension tests on bridge members other than eyebars, and these tests, while not exhaustive, are in a channel outside of the usual run. The investigations are divided as follows: 1. The strength and value of built-up tension members. 2. The net area required back of pin holes in plates having sheared and planed ends. 3. The tensile strength of single angles having ends riveted through one leg or both legs to connection plates. 4. The strength of steel which has been worked partly hot and partly cold.

1. The results of these tests seem to indicate that built-up I sections having double lattice bars for webs and those having batten plates are not so effective as members with single lattice or solid webs. Double lattice webs drew the flange angles together and caused secondary bending strains, which had a tendency to cause fracture to start from the edge of the inner legs of the angles at a rather low indicated stress. Single lattice and solid web plate gave the least distortion. There seems, therefore, no reason why built-up members of these three types should not be used with the same unit stress as is allowed for eyebars, and why the web plates should not be considered as effective section.

2. Pin plates, in which the area back of the holes was more than 75% of the area through the holes, buckled and curled before breaking out, and the milled ends were no stronger than the sheared ends. Those having a ratio less than 75% broke without buckling, and the milled ends developed greater strength. The developed stress per square inch of area back of the holes varied inversely, while the stress per square inch across the holes varied directly as the amount of metal back of the holes. Buckling back of the holes took place in all members in which the ratio of width to thickness was greater than 13. Thicker plates would have had less tendency to buckle. The proper amount of material back of the holes is some fraction of the area across the holes, the diameter of the pins and the thickness of the plate.

3. There is no question as to the superiority of the double connection, and it should be used whenever practicable and when conditions require rigidity. On the other hand, the single connection is not so weak as is usually believed, the test showing the developed strength to be about 83% of the developed strength of eyebars.

4. Comparative tests did not indicate any marked superiority of cold-worked angles over those which had one end worked hot and not annealed, no brittleness or particularly weak area being found. Impact tests failed to reveal any injury due to partly heating steel of this character, except that the ultimate strength was reduced, which, however, does not indicate anything, except that the piece had been softened the same as it would have been by annealing.

Mr. George H. Thomson gave particulars of the test of a built-up eyebar, and another speaker pointed out that rupture in such members is due partially to direct tension and partly to bending consequent upon the length of the pin between the plates of the head. He suggested tests of standard beam connections. Mr. George S. Morison said that he did not know of any tests of average tensile strength and elastic limit of riveted members, and exactly similar members without rivets, but he thought such tests would show interesting results.

At the afternoon session Mr. Henry Goldmark read an abstract of a detailed descriptive paper on "The Power Plant, Pipe Line and Dam of the Pioneer Electric Power Co., at Ogden, Utah." We publish an abstract of this, with notes of the discussion, in another column of this issue.

Mr. Sandford Fleming, of the Committee on Uniform Standard Time, then presented a communication relative to the adoption of the 24-hour notation, and this was, on motion of Mr. Morison, accepted as a communication from the committee, after which a resolution was adopted requesting the Board of Direction to take steps to suggest to the United States government the advisability of adopting this system at the opening of the new century, as recommended by the Washington convention. Col. Craighill said that he had been in favor of this system until, when appointed by the board to act with Mr. B. R. Green in inquiring into this matter, he had had occasion to get the views of an eminent astronomer. It may be noted, however, that the favorable views of a large number of practical men interested in navigation, etc., should not be outweighed by the adverse opinions of a few astronomers, however eminent. This view of the case, from the standpoint of the greatest benefit to the greatest number, has been presented in recent papers on the subject.

Mr. E. P. North called attention to the next meeting of the Congress for the Improvement of Navigation (formerly the Congress for the Improvement of Internal Navigation), which is to be held at Brussels in 1898, and he urged that the United States government be requested to appoint as its representative an army engineer, experienced in harbor works and hydraulic works. This is the only important government not regularly represented in the Congress. A meeting was to have been held in 1898, but had to be abandoned on account of the troubles over the Abyssinian campaign. Gen. Craighill thought there would be no difficulty in inducing the government to appoint an officer for this purpose.

Prof. Fuertes then read a communication in relation to the very completely equipped laboratory for hydraulic tests and investigations, which is now being installed at Cornell University, and the use of which is freely offered to engineers.

The annual vexed question of the appointment of a nominating committee to nominate officers for the coming year then came up for consideration, and after a varied and scattering discussion as to how the complicated arrangements might, could and should be effected, and how they had actually been effected on former occasions, it was voted that the chairman (the president) be requested to nominate a provisionary chairman for each of the six geographical groups into which the membership is divided for nominating purposes, such chairmen to be notified of their appointment by the secretary and to call together the members of their respective groups to select members to represent these groups on the nominating committee, the names of such selected members to be presented at the meeting on the next day. The meeting then adjourned.

On July 1, the meeting was called to order soon after 10 a. m. The committee to award the Collingwood Prize for papers presented by juniors of the Society, announced that the prize for the year 1896 had been awarded to paper No. 779, on "The 28th St. Central Station of the Edison Electric Light Co., New York," by Mr. H. W. York (who has since been transferred to the grade of Member).

The announcement was made that Sir Benjamin Baker, of London, and Prof. George Davidson, of San Francisco, have been elected Honorary Members of the Society. It was also announced that a new set of rules had been adopted for awarding the endowed prizes for papers, by which one committee will award the three prizes each year (the Norman, Rowland and Collingwood prizes).

The votes sent in as to the place for the convention of 1898 numbered 50, of which 6 were for Mackinac, the others being for the usual scattering list of places. The president called attention to the fact that the Society has not met at any point south of Chattanooga for 20 years. After some desultory discussion as to the merits of various places, a vote was taken which showed 78 in favor of some place in the middle West and 14 for some place in the extreme South. As to the time of the convention, nearly every month was suggested. Mr. Morison proposed August, on the ground that the time now usually selected (in June) is about the time of the closing of the college terms, when the educational element of the membership finds it difficult to be present. Mr. Seaman, however, pointed out that June is about the only time when adequate hotel accommodation and special rates can be secured, as it is just before the opening of the regular summer season.

At 10.30 the meeting started to discuss the proposed amendments to the constitution, a large and representative number of members being in attendance. A communication was read from a number of members who have served on the Board of Direction, this communication having a long and strong list of signatures. It stated that the Board of Direction, as at present constituted, is an unwieldy body, and in some important cases requiring prompt action, it has been difficult to obtain a quorum of that body. In addition to this, each president must be for life a member of the Board, with financial responsibilities, and can only escape this by resignation from the Society. It further stated that the signers disapproved of having a secretary who is not a member of the Board. He has varied and responsible duties and has to represent both the Society and the Board at all times, and it is fitting that he should be a member of that Board.

Mr. P. A. Peterson did not think that the past presidents who had signed the proposed amendment really favored the plan of removing past presidents from the Board of Direction, but signed it by request. This view was corroborated by Mr. Wm. Metcalf (himself a past president), who stated that after being asked if he would sign an amendment to constitute the Board somewhat similarly to that of the American Society of Mechanical Engineers, an amendment was sent him to sign. He altered this in some respects, but was told that as altered it would not be legal, and he was asked to sign the amendment as first submitted to him, which he did. Mr. Don J. Whittemore also stated that the matter had been presented to him, and believing that the change was desired, he signed the proposed amendment. Mr. Oberlin Smith thought that the present plan should stand, but if any change is to be made it should be in the line of the plan of the American Society of Mechanical Engineers, by which past presidents are made honorary members of the council, to vote on all questions excepting legal rights or obligations. Mr. Seaman said that the proposed plan intended no discourtesy towards past presidents, but was devised in order to avoid the troubles in administration due to its being in the hands of a board containing so large a number of members. Mr. Robert Moore favored amendment No. 2, making past presidents members of the Board of Direction, but not Trustees, so that they have nothing to do with affairs affecting the property or finances. This amendment might be changed so as to include the secretary on the Board of Direction, though he did not think that an appointee of the board could be rightly a member thereof.

Gen. Craighill then stated that since signing amendment No. 2, he had changed his mind, and now disapproved of both amendments as submitted, but he recognized the desirability of having a more practicably constituted Board of Direction than is possible under the present plan, and he proceeded to submit amendments to amendment No. 1. These were discussed at some length, and were further amended as to drawing and wording until eventually the following form of amendment was adopted, and will be submitted to a letter ballot for adoption by the Society at large.

Proposed Amendment to Section 1 of Article 5 of the Constitution of the Am. Soc. C. E.

The officers of the Society shall be: A President, four Vice-Presidents, eighteen Directors, a Secretary, and a Treasurer, who, with the five latest living Past Presidents, who shall continue to be Members of the Society, shall constitute the Board of Direction, in which the government of the Society shall be vested, and who shall be the Trustees as provided for by laws under which the Society is organized. For the election of Honorary Members, all the Past Presidents shall be members of the Board of Direction, except any Past President who may be disqualified by mental or bodily infirmity, and the evidence of such disqualification of any Past President shall be a certificate from his attending physician or an officer of the Society.

The above amendment was adopted by the meeting (to go to letter ballot) by a vote of 110 to 6, and it was decided by a vote of 92 to 15 that the proposed amendments Nos. 2 and 3 should be amended in the same form.

The chairmen of the several geographical groups of members then submitted the names selected for members of the nominating committee:

No. 1.—Henry B. Seaman, New York city.
No. 2.—E. K. Keating, Toronto, Ont.
No. 3.—Edward W. Howe, Boston, Mass.
No. 4.—John N. Chester, Pittsburg, Pa.
No. 5.—Gouverneur Morris, Detroit, Mich.
No. 6.—James Dun, Topeka, Kan.
No. 7.—A. M. Scott, Charleston, W. Va.

A series of resolutions of thanks for courtesies extended to the Society was then presented and adopted, and also a resolution alluding to the date (July 1) being that of the celebration of "Dominion Day," and wishing prosperity to Canada.

Mr. George A. Just then submitted a brief report from the Building Committee, from which it appeared that owing to a strike of plasterers, etc., the new building will probably not be ready for occupation by September, as had been expected. The Society then adjourned.

In the afternoon there was a steamboat excursion to view the harbor of Quebec, this being tendered to the Society by Mr. J. B. Laliberte, Chairman, and the members of the Quebec Harbor Commission. The party, with a number of citizens as invited guests, filled the two steamers, "St. Louis" and "Champion." The deep water tidal dock was first visited, where steamers and sailing vessels were loading coal and lumber, and then, after a landing to enable the party to visit the stone dry-dock at Levis, on the south shore, the steamers proceeded up the river as far as the site of the proposed bridge, which is to have a channel span of 1,400 ft. Returning, the party landed to attend a garden party at "Beauvoir," the country seat of the Hon. R. R. Dobell, P. C. The party did not reach Quebec until 7.30 p. m., but in spite of the fatigues of the day, there was a very large attendance at the reception given by the Society at the Chateau Frontenac in the evening.

On July 2, a special train on the Quebec & Lake St. John Ry., provided by the courtesy of the Mayor and City Council, conveyed the party to Indian Lorette, where it was received by chief, braves and squaws and an Indian band, all in gala costume, affording great gratification to the numerous amateur photographers. A walk of about a mile brought the party to Chateau d'Eau, where a dam at the headquarters of the St. Charles River forms a reservoir from which the city obtains its water supply by a 24-in. main. Here refreshments were served, and the visitors were entertained by an address from the wife of the chief, bow and arrow shooting by the boys, and a dance of the Indians. The return trip was made in time to give ample opportunity to obtain lunch at the hotel. At 2 p. m. a special train on the Quebec, Montmorency & Charlevoix Ry., provided by the courtesy of Mr. Horace J. Beemer, President of the company, conveyed the party to Ste. Anne de Beaupre, to visit the noted church in which is the relic reported to have such wonderful curative properties, as testified to the numbers of crutches, spectacles, etc., left by persons who have been cured by the relic or by faith therein. The train stopped at Montgomery to give a view of the beautiful Montmorency Falls, 267 ft. high, 150 ft. wide, but much of the beauty has been lost by the diversion of large volumes of water from the river to the flumes for turbines operating a cotton mill and an electric light plant, whose current is transmitted to Quebec for lighting and power purposes. The party arrived in Quebec on its return at about 5.30 p. m., and this practically ended the convention.

On Saturday, July 3, a large party started for a trip to the Saguenay River by the steamer of the Richelieu & Ontario Navigation Co.

The convention was very successful and enjoyable, and the Canadian hosts did everything in their power for the entertainment of the guests.